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Practitioner's Docket No. AP9654

CHAPTER II

TRANSMITTAL LETTER
TO THE UNITED STATES ELECTED OFFICE (EO/US)

(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

PCT/EP00/05033	02/June/2000	19/June/1999
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED

Method and Device for Creating a Compensation Value Table for Determining a Test Variable, and for Identifying the Pressure Loss in a Tire of a Wheel
TITLE OF INVENTION

Martin Grießer; Hans Georg Ihrig
APPLICANT(S)

Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231
ATTENTION: EO/US

NOTE: To avoid abandonment of the application, the applicant shall furnish to the USPTO, not later than 20 months from the priority date: (1) a copy of the international application, unless it has been previously communicated by the International Bureau or unless it was originally filed in the USPTO; and (2) the basic national fee (see 37 C.F.R. § 1.492(a)). The 30-month time limit may not be extended. 37 C.F.R. § 1.495.

CERTIFICATION UNDER 37 C.F.R. 1.10*
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I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United States Postal Service on this date 12/19/01, in an envelope as "Express Mail Post Office to Addressee," Mailing Label Number EV051007674US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Joyce Krumpe
(type or print name of person mailing paper)

Joyce Krumpe
Signature of person mailing paper

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*"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

WARNING: *Where the items are those which can be submitted to complete the entry of the international application into the national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. §1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing - See 37 C.F.R. §1.8.*

NOTE: Documents and fees must be clearly identified as a submission to enter the national state under 35 USC 371 otherwise the submission will be considered as being made under 35 USC 111. 37 C.F.R. § 1.494(f).

1. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. 371:

   a. [X] This express request to immediately begin national examination procedures (35 U.S.C. 371(f)).

   b. [X] The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

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2.Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULA-TIONS
[ ]*	TOTAL CLAIMS	23 - 20 =	3	x $ 18.00 =	$54.00
	INDEPENDENT CLAIMS	7 - 3 =	4	x $ 84.00 =	336.00
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + $280.00				
BASIC FEE**	[ ] U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: [ ] and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(2) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 CFR 1.492(a)(4)) .... $100.00 [ ] and the above requirements are not met (37 CFR 1.492(a)(1)) .... $710.00 [X] U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: [ ] has been paid (37 CFR 1.492(a)(2)) .... $740.00 [ ] has not been paid (37 CFR 1.492(a)(3)) .... $1040.00 [X] where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) $890.00				
	Total of above Calculations				= 890.00
SMALL ENTITY	Reduction by ½ for filing by small entity, if applicable. Affidavit must be filed. (note 37 CFR 1.9, 1.27, 1.28)				-
	Subtotal				
	Total National Fee				$
	Fee for recording the enclosed assignment document $40.00 (37 CFR 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".				
TOTAL	Total Fees enclosed				$1280.00

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*See attached Preliminary Amendment Reducing the Number of Claims.

i. [ ] A check in the amount of ____________ to cover the above fees is enclosed.

ii. [X] Please charge Account No. 18-0013 in the amount of $ 1280.00.
A duplicate copy of this sheet is enclosed.

***WARNING:* *"To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: * * * (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 C.F.R. § 1.495(b).*

WARNING: *If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 C.F.R. § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of Jan. 3, 1993, 1147 O.G. 29 to 40.*

3. [X] A copy of the International application as filed (35 U.S.C. 371(c)(2)):

NOTE: *Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.*

a. [X] is transmitted herewith.

b. [ ] is not required, as the application was filed with the United States Receiving Office.

c. [ ] has been transmitted

i. [ ] by the International Bureau.
Date of mailing of the application (from form PCT/IB/308): __________.

ii. [ ] by applicant on _______.
Date

4. [X] A translation of the International application into the English language (35 U.S.C. 371(c)(2)):

a. [X] is transmitted herewith.

b. [ ] is not required as the application was filed in English.

c. [ ] was previously transmitted by applicant on _________________.
Date

d. [ ] will follow.

5. [ ] Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. 371(c)(3)):

NOTE: *The Notice of January 7, 1993 points out that 37 C.F.R. § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.*

a. [ ] are transmitted herewith.
b. [ ] have been transmitted
 i. [ ] by the International Bureau.
 Date of mailing of the amendment (from form PCT/IB/308): __________.
 ii. [ ] by applicant on _______.
 Date
c. [ ] have not been transmitted as
 i. [ ] applicant chose not to make amendments under PCT Article 19.
 Date of mailing of Search Report (from form PCT/ISA/210): __________.
 ii. [ ] the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. [ ] A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. 371(c)(3)):
 a. [ ] is transmitted herewith.
 b. [ ] is not required as the amendments were made in the English language.
 c. [ ] has not been transmitted for reasons indicated at point 5(c) above.

7. [x] A copy of the international examination report (PCT/IPEA/409)
 [x] is transmitted herewith.
 [ ] is not required as the application was filed with the United States Receiving Office.

8. [x] Annex(es) to the international preliminary examination report
 a. [x] is/are transmitted herewith.
 b. [ ] is/are not required as the application was filed with the United States Receiving Office.

9. [ ] A translation of the annexes to the international preliminary examination report
 a. [ ] is transmitted herewith.
 b. [ ] is not required as the annexes are in the English language.

10. [X] An oath or declaration of the inventor (35 U.S.C. 371(c)(4)) complying with 35 U.S.C. 115
 a. [ ] was previously submitted by applicant on ____________.
 Date
 b. [x] is submitted herewith, and such oath or declaration
 i. [x] is attached to the application.
 ii. [ ] identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. 1.70.

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iii. [ ] will follow.

Other document(s) or information included:

11. [x] An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):
   a. [x] is transmitted herewith.
   b. [ ] has been transmitted by the International Bureau.
      Date of mailing (from form PCT/IB/308): _________________.
   c. [ ] is not required, as the application was searched by the United States International Searching Authority.
   d. [ ] will be transmitted promptly upon request.
   e. [ ] has been submitted by applicant on _________________.
      Date

12. [X] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98:
   a. [X] is transmitted herewith.
      Also transmitted herewith is/are:
      [X] Form PTO-1449 (PTO/SB/08A and 08B).
      [X] Copies of citations listed.
   b. [ ] will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. 371(c).
   c. [ ] was previously submitted by applicant on _________________.
      Date

13. [ ] An assignment document is transmitted herewith for recording.

A separate [ ] "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or[ ] FORM PTO 1595 is also attached.

14. [X] Additional documents:
   a. [ ] Copy of request (PCT/RO/101)
   b. [x] International Publication No. WO00/78566
      i. [ ] Specification, claims and drawing
      ii. [x] Front page only
   c. [X] Preliminary amendment (37 C.F.R. § 1.121)
   d. [ ] Other

15. [X] The above checked items are being transmitted

a. [X] before 30 months from any claimed priority date.
b. [ ] after 30 months.

16. [ ] Certain requirements under 35 U.S.C. 371 were previously submitted by the applicant on ____________, namely:

____
____
____

AUTHORIZATION TO CHARGE ADDITIONAL FEES

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges if extra claims are authorized.*

NOTE: *"A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).*

NOTE: *"Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).*

[X] The Commissioner is hereby authorized to charge the following additional fees that may be required by this paper and during the entire pendency of this application to Account No. 18-0013.

[X] 37 C.F.R. 1.492(a)(1), (2), (3), and (4) (filing fees)

WARNING: *Because failure to pay the national fee within 30 months without extension (37 C.F.R. § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.*

[X] 37 C.F.R. 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: *Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action.*

[X] 37 C.F.R. 1.17 (application processing fees)
[X] 37 C.F.R. 1.17(a)(1)-(5)(extension fees pursuant to § 1.136(a).
[ ] 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

NOTE: *Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of*

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allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

[X] 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

SIGNATURE OF PRACTITIONER

Reg. No.: 33,373

Joseph V. Coppola, Sr.
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AP9654

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Griesser et al

Int'l Application No.: PCT/EP00/05033

Int'l Filing Date: 02/June/2000

Serial No.: Group Art Unit:

Filed: Herewith Examiner:

For: Method and Device for Creating a Compensation Value Table, for Determining a Test Variable, and for Identifying the Pressure Loss in a Tire of a Wheel

Attorney Docket No.: AP9654 Paper No.

Box PCT
Commissioner of Patents
Washington, D.C. 20231
Attn: EO/US

CERTIFICATE OF MAILING/TRANSMISSION (37 CFR 1.8(a))

I hereby certify that this correspondence is, on the date shown below, being:

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☐ transmitted by facsimile to the Patent and Trademark Office. to Examiner ________ at ________

Joyce Krumpe
Signature

Date: 12/19/01

Joyce Krumpe

PRELIMINARY AMENDMENT

Dear Sir:

Please amend the application as follows prior to examination on the merits.

IN THE CLAIMS

Please cancel claims 1-23 and add the following new claims.

24. (New) Method for creating a correction value table, for determining a test variable, and for identifying the pressure loss in a tire of a vehicle, wherein the test variable is a quotient of each two sums of two wheel radii or variables mirroring these wheel radii, comprising the steps of:

determining a driving dynamics variable of the vehicle, and

determining a correction value for the test variable and storing the said in dependence on the value of the driving dynamics variable which prevailed during the correction value determination.

25. (New) Method as claimed in claim 24, wherein the correction value determination takes place only when the vehicle dynamics with respect to their values satisfies defined conditions.

26. (New) Method as claimed in claim 25, wherein the correction value determination or storage takes place only when the vehicle dynamics has remained within a defined value range for a defined period of time.

27. (New) Method as claimed in claim 24, wherein the test variable is determined from the wheel radii or from variables mirroring these wheel radii of at least two wheels.

28. (New) Method as claimed in claim 24, wherein the correction value determination takes place only when the vehicle dynamics with respect to their time variations satisfies defined conditions.

29. (New) Method as claimed in claim 28, wherein one sum is produced with reference to variables on front wheels of the vehicle and the other sum is produced with reference to variables on rear wheels of the vehicle.

30. (New) Method as claimed in claim 28, wherein one sum is produced with reference to variables on wheels of the right vehicle side and the other sum is produced with reference to variables on wheels of the left vehicle side.

31. (New) Method as claimed in claim 28, wherein one sum is produced with reference to variables on the wheels on the one vehicle diagonal and the other sum is produced with reference to variables on wheels of the other vehicle diagonal.

32. (New) Method as claimed in claim 24, wherein the correction values are determined for several values of the driving dynamics variable, and correction values are extrapolated from the determined correction values for other values of the driving dynamics variable.

33. (New) Method as claimed in claim 24, wherein the driving dynamics variable is a wheel torque which is determined from the engine torque and the gear ratio.

34. (New) Method as claimed in claim 33, wherein the gear ratio is determined from the engine speed and the wheel speed.

35. (New) Method as claimed in claim 24, wherein the driving dynamics variable is a curve characteristic value acquired during cornering maneuvers.

36. (New) Method as claimed in claim 35, wherein as the curve characteristic value, one or more of the following variables can be taken into account:

the yaw rate, also in connection with the vehicle speed or acceleration,

the curve radius in connection with the vehicle speed or the vehicle acceleration,

the steering angle in connection with the vehicle speed or the vehicle acceleration,

the transverse acceleration, also in connection with the vehicle speed or acceleration.

37. (New) Method as claimed in claim 36, wherein the correction value is stored in dependence on several curve characteristic values.

38. (New) Method of determining a corrected test variable for identifying a pressure loss in the tires of a vehicle, comprising the steps of:

determining a test variable from the wheel radii or from variables mirroring these wheel radii of at least two wheels,

preparing a correction value table,

determining a driving dynamics variable of the vehicle,

reading a correction value from the table in accordance with the value of the driving dynamics variable, and

correcting the test variable by means of the correction value.

39. (New) Method of determining a corrected test variable for identifying a pressure loss in the tires of a vehicle, comprising the steps of:

determining a test variable from the wheel radii or from variables mirroring these wheel radii of at least two wheels,

preparing a correction value table,

determining a driving dynamics variable of the vehicle,

reading a correction value from the table in accordance with the value of the driving dynamics variable, and

directly comparing the test variable with reference values which are determined in dependence on the driving dynamics variable and stored in the table.

40. (New) Method as claimed in claim 39, wherein the determination of test variables is a function of wheel radii or of variables mirroring the wheel radii of at least two wheels.

41. (New) Method of identifying the pressure loss in a tire of a wheel, comprising the steps of:

determining a test variable for identifying pressure loss in the tire of a vehicle,

comparing the test variable with a threshold value, and

identifying pressure loss when the test variable reaches or passes the threshold value.

42. (New) Method as claimed in claim 41, wherein when pressure loss is assumed at any one of the driven wheels, the threshold value is modified so that the pressure loss identification becomes more sensitive.

43. (New) Device for preparing a correction value table for a test variable for identifying the pressure loss in the tire of a vehicle, comprising

a first determination device for determining a driving dynamics variable of the vehicle, and

a second determination device for determining a correction value and storing the said in a memory in dependence on the value of the driving dynamics variable which prevailed during the determination of the correction value.

44. (New) Device for determining a corrected test variable for the pressure in the tires of a vehicle, comprising:

a first determination device for determining a test variable for the tire pressure,

a preparation device for preparing a correction value table for a test variable,

a second determination device for determining the driving dynamics variable,

a reading device for reading out a correction value in accordance with the driving dynamics variable from the table, and

a correction device for correcting the test variable in accordance with the read-out correction value.

45. (New) Device for identifying the pressure loss in a tire of a wheel, comprising:

a determination device for determining a test variable for the tire pressure in the tires of a vehicle,

a comparison device for comparing the test variable with a threshold value, and

an identification device for identifying a pressure loss when the test variable reaches or passes the threshold value.

46. (New) Device as claimed in claim 45, comprising a modification device which changes the threshold value accordingly when a pressure loss is assumed.

REMARKS

Prior to a formal examination of the above-identified application, acceptance of the new claims and the enclosed substitute specification (under 37 CFR 1.125) is respectfully requested. It is believed that the substitute specification and new claims will facilitate processing of the application in accordance with M.P.E.P. 608.01(q). The substitute specification and new claims are in compliance with 37 CFR 1.52 (a and b) and, while making no substantive changes, are submitted to conform this case to the formal requirements and long-established formal standards of U.S. Patent Office practice, and to provide improved idiom and better grammatical form.

The enclosed substitute specification is presented herein in both marked-up and clean versions.

STATEMENT

The undersigned, an attorney registered to practice before the office, hereby states that the enclosed substitute specification includes the same changes as are indicated in the mark-up copy of the original specification. The substitute specification contains no new

subject matter.

Respectfully submitted,

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Attorney for Applicants
CUSTOMER NO. 010291

SUBSTITUTE SPECIFICATION: CLEAN COPY

PC 9654

Method and Device for Creating a Compensation Value Table, for Determining a Test Variable, and for Identifying the Pressure Loss in a Tire of a Wheel

TECHNICAL FIELD

[0001] The present invention relates to a method and a device for creating a correction value table, for determining a test variable, and for identifying the pressure loss in a tire of a wheel.

BACKGROUND OF THE INVENTION

[0002] A method for identifying pressure loss of this type is disclosed in DE 19 721 480 A1.

[0003] Basic physical correlations are explained by way of Figure 6. Reference numeral 61 represents a regular wheel on the roadway 60. The wheel center 63 moves with the vehicle chassis and, thus, at the vehicle speed Vf. Corresponding to the generally accepted relationship between the track speed v of a point on a disc rotating with the angular speed ω, with the said point being spaced from the center of rotation by the radius R, i.e., $\omega = v/R$, $\omega r = vF/Rr$ results on the left side of Figure 6. The angular velocity ω of vehicle wheels can be determined by means of wheel sensors, while the vehicle speed v generally cannot be sensed by sensors. The dynamic rolling circumference of a wheel varies in the event of pressure loss. The wheel rotates faster compared to the normal condition or compared to the wheel without pressure loss.

[0004] Additional effects can influence the angular velocities of the wheels, but the resulting difference between

the angular velocities of individual wheels would not indicate pressure loss in any one of the wheels. Examples herefor are traction slip, different geometries during cornering, unsymmetrical load distribution in the vehicle, or similar factors. Two effects which result drom driving dynamics, especially during cornering or in the traction case, will be explained referring to Figures 1A to 1C.

[0005] Figure 1A shows a vehicle 10 with left front wheel 11, right front wheel 12, right rear wheel 13, and left rear wheel 14. The vehicle rides at a speed vF in a curve to the right, and it is assumed that the vehicle's point of gravity S follows the radius R about the center M. The wheels 12 and 13 on the right-hand side of the vehicle roll on the inner track and, therefore, have a track with approximately the same smaller inside radius Ri, while the wheels 11 and 14 on the left-hand side of the vehicle roll on the outer track and, hence, ride in a curve with the larger outside radius Ra. Because they have to cover a larger distance in the same time, the curve-outward wheels 11 and 14 exhibit a higher track speed and, thus, also a higher angular velocity than the curve-inward wheels 12 and 13. However, these differences are not due to a pressure loss in any one of the wheels.

[0006] Another effect is explained with reference to Figure 1B. The vehicle shown in Figure 1A is shown from the back, it follows the same track as the vehicle shown in Figure 1A (curve to the right, i.e., to the right into the drawing plane in Figure 1B) about the center M with radius R. A centrifugal force Fz which is applied to the vehicle point of gravity S is produced due to the cornering maneuver. The counterforce is the friction force Fr between the vehicle wheels and the roadway. Because these forces do not act in the same plane, a rolling moment Mr is produced in the mentioned situation

counterclockwise about the longitudinal axis of the vehicle. This brings about that the curve-outward wheels 11 and 14 are subjected to greater stress than the curve-inward wheels 12 and 13. The result is that they are more compressed, hence show a smaller dynamic rolling radius and a higher angular velocity. The effect of Figure 1B points to the same direction as the one described by way of Figure 1A so that they add.

[0007] Figure 1C shows a situation in which the vehicle 10 moves on the roadway 15 driven by engine 16. In the example of Figure 1 the rear axle is driven so that the wheels 13, 14 of this axle will exhibit both traction slip and brake slip, while the wheels of the front axle 11, 12 can only exhibit brake slip. Especially in the case of traction, the wheels 11, 12 of the front axle roll freely and, hence, have an angular velocity $\omega = vF/R$, while the wheels of the rear axle frequently have a higher amount because the wheel slip ωs adds to the above-mentioned amount ω. Likewise this effect has nothing to do with different angular velocities due to pressure loss in any one of the tires.

[0008] In view of the above, it is important to eliminate disturbing effects according to Figures 1A to 1C. In this respect, DE 19 721 480 A1 discloses a method wherein wheel speeds are added in pairs, the sums are brought into a relation to each other, and the value of the quotient is checked. More particularly, a method is disclosed wherein the wheel speeds of the wheels lying on a diagonal are added and the results achieved are divided. A quotient will thus be calculated which differs more or less from the ideal value 1 (constant velocity of all wheels). When especially a tire with pressure loss exists, a considerably lower value will occur either in the numerator or the denominator of the fraction so that, for this reason, the resulting quotient will also differ greatly from

the ideal value 1, upwards or downwards. Further tests may then be performed in order to detect a wheel with pressure loss, if there is one. Effects of curve geometries or traction slip are frequently compensated by considering or summing the values of diagonally opposite wheels. On the other hand, this compensation not always occurs with certainty so that comparatively wide tolerances must be chosen to avoid wrong detections. The result is that the detection occurs only at a relatively late point. During cornering maneuvers, for example, differential locks may prevent the compensation of effects due to different curve geometries. When one axle is locked, the wheels of the axle roll with the same track speed and angular velocity so that they cannot contribute to compensating the unbalance in the summation to the respective other partner.

BRIEF SUMMARY OF THE INVENTION

[0009] An object of the present invention is to provide a method and a device for creating a correction value table, for determining a test variable, and for identifying the pressure loss in a tire of a wheel, permitting a reliable detection of pressure drop in a tire.

[0010] This object is achieved with a method for creating a correction value table, for determining a test variable, and for identifying the pressure loss in a tire of a vehicle, wherein the test variable is a quotient of each two sums of two wheel radii or variables mirroring these wheel radii, comprising the steps

[0011] determining a driving dynamics variable of the vehicle, and

[0012] determining a correction value for the test variable and storing the said in dependence on the value of the driving

dynamics variable which prevailed during the correction value determination.

[0013] In the method for creating a correction value table for a test variable for identifying a pressure loss in the tire of a vehicle, individual correction values are determined for the test value and stored in dependence on the value of a driving dynamics magnitude which prevailed during or at the point of time of the correction value determination. A table of correction values is this way prepared in the course of time. The input variable of the table is the driving dynamics variable, the output value is thus a driving-dynamics responsive correction value so that the test variable for identifying a pressure loss in the tire of a vehicle can be corrected in dependence on driving dynamics.

[0014] The determination of the correction value is a learning operation. The correction value can be determined when the vehicle dynamics, in particular the driving dynamics variable satisfies defined conditions with respect to their values or with respect to their time variations, no matter whether absolute or relative. More particularly, the demand may be that the vehicle dynamics or especially the driving dynamics variable referred to has a certain constancy (within a range of values within a time window), or that the variation of driving dynamics is lower than a threshold value. The test variable may be determined from several wheel radii or quantities which correspond to these wheel radii. For example, the test variable may be a quotient of two sums of two wheel radii each.

[0015] The possible range of values of the driving dynamics variable can be subdivided into ranges. When the value of the driving dynamics variable is represented digitally, the range division may occur already due to the digital quantization.

Correction values may be determined as described hereinabove for individual or several values of the driving dynamics variable. For other values of the driving dynamics variable, correction values may be determined by interpolation with appropriate methods (linear, in general polynomial).

[0016] The driving dynamics variable may be a wheel torque and/or a curve characteristic value. The test variable may be determined from the variables of several wheels of the vehicle. In particular, it may be the quotient of two sums of such variables.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Figures 1A to 1C show views to explain the influence of disturbances.

[0018] Figure 2 shows representations of ideal and real variations of test variables.

[0019] Figure 3 is a block diagram of a device for creating correction value tables.

[0020] Figure 4 is a block diagram of a device for determining a test variable for the tire pressure.

[0021] Figure 5 is a device for identifying the pressure loss in a tire of a wheel.

[0022] Figure 6 is a representation for explaining physical correlations.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] In the embodiment of Figure 3, reference numeral 30 generally designates the device for preparing a correction value table. Said device receives sensor signals from sensors 31 and 32, and reference numeral 31 designates the four wheel sensors (one on each wheel), reference numeral 32 designates further sensors such as acceleration sensor, yaw rate sensor, steering angle sensor, transmission sensor, engine rotation sensor, and similar elements in Figure 3. In general, digital data are concerned which have already passed through various conditioning stages (conversion, filtering, standardization). The data can be tapped by a vehicle data bus 37.

[0024] Reference numeral 33 represents a first determination device for determining a driving dynamics variable. The first determination device 33 may receive especially the wheel signals and, as the case may be, further sensor signals or status variables from other control components and may determine therefrom the driving dynamics variable of the vehicle. For example, device 33 may determine a wheel torque and/or a curve characteristic value.

[0025] The first determination device 33 determines the value of the driving dynamics variable generally also as a digital variable. A range division of the maximum possible value range of the driving dynamics variable follows already due to this quantization which results from digitizing. The range division may be more or less coarse, as desired. In the event of a curve characteristic value, it may be sufficient to select three ranges, i.e., left, straight, and right. Of course, finer gradings are also feasible. Equally the same applies when the driving dynamics variable is the drive torque.

There may be embodiments where the method described is effected only in a traction case (wheel torque is greater than zero) because it may be assumed in this case that the non-driven wheels roll freely.

[0026] In another embodiment, the method is used in the unclutched case, or in the no-traction and no-braking case (wheel torque is roughly 0) when all wheels roll freely.

[0027] Reference numeral 34 represents a second determination device for determining a correction value and for storing the said in a memory 35 in dependence on the value of the driving dynamics variable which prevailed during the determination of the correction value. The second determination device 34 may also receive the wheel signals and further sensor signals. It will perform comparatively complex testing and determining operations. Device 34 itself may receive the test variable to be corrected (represented by block 36). In the second determination device 34, time variations (e.g. derivative, fluctuation within a time window) of the test variable 36 and/or the driving dynamics variable from the first determination device 33 or values of these variables can be tested as to whether they exceed threshold values or remain under them. The second determination device 34 finally determines a correction value for the test variable. The correction value is determined for a defined value of the driving dynamics variable so that it is generally demanded that the driving dynamics variable remains within the value range considered or leaves said only briefly or only insignificantly during the determination of the correction value.

[0028] After the determination of the correction value, the said is registered in the memory 35 in dependence on the value of the driving dynamics variable. The (digital) value of the

driving dynamics variable may serve as an address of the memory location or can be taken into account for the address determination. Reference numeral 38 represents a data line for the correction value, 39 refers to an address line on which the driving dynamics variable mirrors.

[0029] The individual items of the table are determined as they are available. The adjustment of the driving dynamics variable is generally achieved from the condition adjusted by the driver. A correction value is determined for the respectively prevailing value of the driving dynamics variable if the other conditions permit so. The determined correction value is then written in the corresponding table position. This way, a table is prepared in the course of time. For defined values of the driving dynamics variable, correction values can be extrapolated from determined correction values which apply to other values of the driving dynamics variable, for example, by linear or quadratic extrapolation. Extrapolated values may later be overwritten by determined values.

[0030] Correlations between a curve characteristic value and a test variable are determined and stored in one embodiment of the correction value table.

[0031] In general, the determination of correction values is a learning process wherein it is ensured also by testing conditions which are due to driving situations that only the desired error variable but no other variables are represented in the learnt correction value.

[0032] The memory 35 may be a volatile memory whose values get lost when the current supply is switched off (deactivation of the vehicle or removal of said's battery). But the memory

may also be a non-volatile memory so that the learnt values in the memory 35 survive an interruption of the current supply.

[0033] The stored correction values serve for the correction of a test variable for the tire pressure. The test variable may be so that it qualitatively furnishes a hint at the existence of a pressure loss at any one of the vehicle wheels, but does not yet give a specific hint as to which wheel actually suffers from pressure loss. More particularly, the test variable may be a variable whose value is determined from the wheel radii of at least two wheels. Instead of the wheel radii, variables mirroring these wheel radii, e.g. the wheel speeds, may be used. Several qualitatively different test variables may prevail so that also several different correction value tables would have to be created.

[0034] The test variable may be a quotient of two sums, and each sum is calculated of the wheel radii of two of the four wheels of the vehicle. The sums contain pairwise different wheel radii. One sum may be produced from the wheel radii at the front of the vehicle, and the other one may be produced from the wheel radii at the rear of the vehicle. The quotient of these two sums forms a test variable for which, as described above, in dependence on the value of the driving dynamics variable, correction values are determined in order to develop a correction value table whose input value is the value of the driving dynamics variable.

[0035] A qualitatively different test variable may be produced as a quotient of a sum of the wheel radii on the left side of the vehicle and of a sum of the wheel radii on the right side of the vehicle.

[0036] A wheel which decreases due to tire pressure loss and, conseǵquently, rotates faster will cause a discrepancy of the resulting quotient from the standard value in all the mentioned test variables so that the tire pressure loss can be detected from this discrepancy.

[0037] The driving dynamics variable may be a wheel torque or a variable which was determined with respect to one or more wheel torques (e.g. average value, maximum, or minimum). A wheel torque can be determined with respect to an e.g. measured engine output torque and the gear ratio prevailing between engine and wheel. It is principally possible to derive the engine torque from the indexed engine torque-friction torque.

[0038] The gear ratio can be determined from the engine speed and the wheel speed. An unclutched condition is taken into account acccordingly. This information may be made available by way of a data bus, or this information may be obtained from plausibility considerations.

[0039] The friction torque of engine and transmission may also be considered in the determination of the wheel torque.

[0040] The driving dynamics variable may also be a curve characteristic value. Especially, one or more of the following variables may be taken into account in this connection: the yaw rate (angular speed about the vertical axis, from sensor or determination device), the curve radius in connection with the vehicle speed or the vehicle acceleration, the steering angle in connection with the vehicle speed or the vehicle acceleration, the transverse acceleration (from sensor or determination device). The curve characteristic value can be determined from the wheel signals and/or from other sensor signals or signals found. The curve characteristic value can be

produced redundantly. The determination of the curve characteristic values may be designed so that it primarily operates with reference to the wheel signals, however, that the determination of curve characteristic values is effected with reference to other signals, when e.g. a wheel signal is disturbed. Inasfar as the curve characteristic value is determined with reference to signals from a yaw rate sensor and/or acceleration sensor, provision must be made that backward travel of a vehicle will not cause errors. In case of need, signs must be reversed.

[0041] The preparation of the correction value table may also be made dependent on general conditions. For example, it may be made at or after defined kilometer readings. It may also take place upon the request of a driver. Generally, conditions may be chosen which prevent that actual tire pressure losses are learnt as correction factors which could cause non-detection of a tire pressure loss. On the other hand, the time variation of the individual correction values can be monitored. When a correction value changes continuously in one direction within a defined duration (e.g. during two hours) and/or within a defined distance (e.g. within 150 km), this may be an indication that an actual pressure loss is erroneously learnt as a correction value. This may then lead to an alarm.

[0042] Figures 2A to 2C show ideal and real variations of different test variables PG in dependence on different driving dynamics variables, i.e., in dependence on the curve characteristic value KKG (Figures 2A and 2B) or in dependence on the wheel torque RM (Figure 2C).

[0043] Figure 2A shows on the left side the ideal variation of a test variable which was calculated as follows:

$$PG = \frac{r11 + r14}{r12 + r13}$$

wherein the values r are wheel radii or corresponding values (e.g., angular velocity, and it must then be considered that they behave inversely to the radii), and the numerals are assigned to identify the individual wheels corresponding to the reference numerals in Figure 1A. In the ideal variation (left), the test variable PG adopts the value 1 with a curve characteristic value 0 (straight travel) because ideally all wheels rotate equally quickly at like wheel radii so that numerator and denominator adopt the same value and said's quotient adopts the value 1. However, the real variation is different for most various reasons, and namely both with respect to the zero point and with respect to the gradient. The latter is illustrated on the right in Figure 2A. The test variable no longer runs through point 0/1, for example, due to differently worn tires or an unsymmetrical vehicle loading, and also the gradient may be different. It is principally pointed out that the curve characteristic value is represented only qualitatively. The variation does not have to be similar to a straight line. However, a monotonous behavior (rising or declining) must be expected over the curve characteristic value which eventually mirrors the different wheel speeds due to the geometrical correlations explained in Figure 1A.

[0044] Figure 2B shows the ideal and real variation of the test variable PG which was determined as follows:

$$PG = \frac{r11 + r13}{r12 + r14}$$

[0045] In this case, the values of the diagonals were respectively added and the sums are calculated to form the quotient. In the ideal variation (Figure 2B left), the different geometry conditions are neutralized so that a straight course through the point 1 on the ordinate would have to be expected. In this case, too, other real variations will be caused due to different disturbances which are not due to pressure losses. One example is shown on the right in Figure 2B. Again, the test variable does not run through the point 0/1 and may have a determined gradient also in this case, and again it must be pointed out once more that it is not necessarily a straight line that represents the correct variation of the test variable.

[0046] Figure 2C shows the variation of the test variable PG in dependence on the wheel torque, and the test variable was determined as follows:

$$PG = \frac{r11 + r12}{r13 + r14}$$

[0047] Inasfar as only the traction case (wheel torque is considered as positive) is looked at, a characteristic curve variation results only for positive wheel torques. In the ideal variation (Figure 2C left) the value 1 results for the wheel torque 0 because then all wheels with the same radius run freely and, thus, equally quickly so that identical values are achieved in the numerator and the denominator of the fraction. Herein, too, discrepancies may occur in the real case (Figure 2C right). In the non-traction case, the value is not required to be at zero, and also the further variation (e.g. the gradient of a straight line) may be different (see Figure 2C

right). In an overrun condition, a characteristic curve variation occurs only for negative wheel torques.

[0048] The real variations shown on the right side in Figures 2A to 2C show discrepancies from the ideal variation which take place due to secondary disturbances of most different causes (worn tires, unsymmetrical loading condition of the vehicle), which apart from the primary disturbances (curve geometry, rolling moment, traction slip) may cause discrepancies of the test variable from the ideal variation which have nothing to do with a pressure loss in a tire that will possibly be detected. These further coefficients of influence are eliminated by learning the correction values.

[0049] Figure 4 shows a device for determining a test variable for the tire pressure in the tires of a vehicle. It includes a preparation device 30 for preparing a correction value table, stored in memory 35 for the test variable. The preparation device 30 can be designed as described hereinabove or as illustrated in Figure 3. Further, the test variable determination device includes a second determination device 41 for determining a driving dynamics variable. This variable is that driving dynamics variable which is required as an input quantity for the correction value table stored in memory 35. The second determination device 41 may be the same as the first determination device 33.

[0050] A third determination device 42 determines the driving dynamics variable in a conventional fashion, for example, by determining the variable with reference to the wheel radii of several wheels. Methods known in the art may be used for this purpose. The quotients described above can be calculated from sums.

[0051] A reading device 43 reads a correction value from the correction value table in the memory 35 in accordance with the driving dynamics variable determined in the second determination device 41.

[0052] A correction device 44 corrects the value of the test variable determined by the second determination device 41. The correction value may be an additive value or a factor by which the determined value is added or multiplied. When the test variable is the quotient of two 'symmetric' sums, the ideal value amounts to 1. A real value can differ therefrom and e.g. amount to 0.97. By using the correction value, the value of the test variable would be caused to reach e.g. 1.00 again.

[0053] Figure 5 shows a device for identifying the pressure loss in a tire of a wheel. The identification device includes a determination device 40 for determining a test variable for the tire pressure. The determination device can be designed as described hereinabove and especially as shown schematically in Figure 4. It determines a corrected test variable, and the said test variable is determined with reference to wheel radii of several wheels of the vehicle.

[0054] Besides, the identification device includes a comparison device 51 which compares the corrected test variable with one or more threshold values. A discrepancy which still exists after the correction would be an indication that either the numerator or the denominator of the fraction due to pressure loss shows a changed value so that, accordingly, the quotient changes as well. Because the change may be in the numerator or in the denominator, the test variable can be tested with respect to whether it exceeds a top threshold value that lies above the standard value and with respect to whether it remains under a bottom threshold value that lies below the

standard value. The threshold values are represented by reference numeral 55. In these threshold value tests, too, time considerations may be performed to prevent that single runaways of the corrected test variable will cause wrong identifications. Likewise the test variable itself (corrected or not corrected) may still be subject to processing operations, for example, filtering or smoothing e.g. by low-pass filtering or averaging over a time window. The time consideration during the threshold value test which is performed in a characteristic curve device 53 may comprise the checking operation whether the 'runaway condition' lasts longer than a defined duration or, within a defined first period, lasts longer than a defined shorter second period in total.

[0055] When finally the result is that the test variable has reached or passed a threshold value, this is a first indication of the existence of pressure loss. Inasfar as the test variable is determined with reference to the wheel radii of several wheels of the vehicle, this test does not yet permit gathering which wheel actually suffers from the pressure loss. However, it can be concluded from the information about whether the variable has exceeded the top threshold value or remained under the bottom threshold value which wheel pair suffers from pressure loss. As the case may be, a qualitatively different test variable may then be used to determine the exact wheel where pressure loss prevails.

[0056] Both the determination of correction values and the determination of test variables and the pressure loss identification may be effected speed-responsively. The vehicle speed may thus be another table input when the correction value table is prepared.

[0057] When the result of a checking operation is that the test variable has reached or passed a threshold value, this can be considered as a first assumption of pressure loss. The further procedure may be that, based on this assumption, the test threshold values are changed by way of a modification device 54 so that the pressure loss identification is less sensitive. If then, preferably within a determined time or path window, the modified threshold value is again reached or passed, pressure loss identification is affirmed, and an alarm is triggered.

[0058] If the curve characteristic value is a wheel torque, the test variable may be the quotient of the sum of the wheel radii at the front and the sum of the wheel radii at the rear axle. With the first assumption of a pressure loss, the threshold values can be influenced so that the threshold values on the driven axle are modified differently for further identification operations than those on the non-driven axle. The modification may also be effected in dependence on the wheel torque and/or the gear step of the vehicle.

Method and Device for Creating a Compensation Value Table, for Determining a Test Variable, and for Identifying the Pressure Loss in a Tire of a Wheel

ABSTRACT OF THE DISCLOSURE

[0059] A method for creating a correction value table for a test variable for identifying the pressure loss in a tire of a vehicle comprises the steps of determining a driving dynamics variable of the vehicle, determining a correction value for the test variable, and storing the said in dependence on the value of the driving dynamics variable that prevailed during the correction value determination. A method of determining a corrected test variable for identifying a pressure loss in the tire of a vehicle comprises the steps of determining a test variable from the wheel radii or from variables that mirror these wheel radii of at least two wheels, preparing a correction value table by means of the method as described hereinabove, determining a driving dynamics variable of the vehicle, reading out of a correction value from the table in accordance with the value of the driving dynamics variable, and correcting the test variable by means of the correction value. A method of identifying the pressure loss in a tire of a wheel comprises the steps of determining a test variable for identifying the pressure loss in the tire of a vehicle by means of the method as described hereinabove, comparing the test variable with a threshold value, and identifying a pressure loss when the test variable reaches or passes the threshold value.

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Method and Device for Creating a Compensation Value Table, for Determining a Test Variable, and for Identifying the Pressure Loss in a Tire of a Wheel

TECHNICAL FIELD

The present invention relates to a method and a device for creating a correction value table, for determining a test variable, and for identifying the pressure loss in a tire of a wheel [according to the preambles of the independent claims].

BACKGROUND OF THE INVENTION

A method for identifying pressure loss of this type is disclosed in DE 19 721 480 A1.

Basic physical correlations are explained by way of Figure 6. Reference numeral 61 represents a regular wheel on the roadway 60. The wheel center 63 moves with the vehicle chassis and, thus, at the vehicle speed Vf. Corresponding to the generally accepted relationship between the track speed v of a point on a disc rotating with the angular speed ω, with the said point being spaced from the center of rotation by the radius R, i.e., $\omega = v/R$, $\omega r = vF/Rr$ results on the left side of Figure 6. The angular velocity ω of vehicle wheels can be determined by means of wheel sensors, while the vehicle speed v generally cannot be sensed by sensors. The dynamic rolling circumference of a wheel varies in the event of pressure loss. The wheel rotates faster compared to the normal condition or compared to the wheel without pressure loss.

Additional effects can influence the angular velocities of the wheels, but the resulting difference between the angular

velocities of individual wheels would not indicate pressure loss in any one of the wheels. Examples herefor are traction slip, different geometries during cornering, unsymmetrical load distribution in the vehicle, or similar factors. Two effects which result drom driving dynamics, especially during cornering or in the traction case, will be explained referring to Figures 1A to 1C.

Figure 1A shows a vehicle 10 with left front wheel 11, right front wheel 12, right rear wheel 13, and left rear wheel 14. The vehicle rides at a speed vF in a curve to the right, and it is assumed that the vehicle's point of gravity S follows the radius R about the center M. The wheels 12 and 13 on the right-hand side of the vehicle roll on the inner track and, therefore, have a track with approximately the same smaller inside radius Ri, while the wheels 11 and 14 on the left-hand side of the vehicle roll on the outer track and, hence, ride in a curve with the larger outside radius Ra. Because they have to cover a larger distance in the same time, the curve-outward wheels 11 and 14 exhibit a higher track speed and, thus, also a higher angular velocity than the curve-inward wheels 12 and 13. However, these differences are not due to a pressure loss in any one of the wheels.

Another effect is explained with reference to Figure 1B. The vehicle shown in Figure 1A is shown from the back, it follows the same track as the vehicle shown in Figure 1A (curve to the right, i.e., to the right into the drawing plane in Figure 1B) about the center M with radius R. A centrifugal force Fz which is applied to the vehicle point of gravity S is produced due to the cornering maneuver. The counterforce is the friction force Fr between the vehicle wheels and the roadway. Because these forces do not act in the same plane, a rolling moment Mr is produced in the mentioned situation counterclockwise about the

longitudinal axis of the vehicle. This brings about that the curve-outward wheels 11 and 14 are subjected to greater stress than the curve-inward wheels 12 and 13. The result is that they are more compressed, hence show a smaller dynamic rolling radius and a higher angular velocity. The effect of Figure 1B points to the same direction as the one described by way of Figure 1A so that they add.

Figure 1C shows a situation in which the vehicle 10 moves on the roadway 15 driven by engine 16. In the example of Figure 1 the rear axle is driven so that the wheels 13, 14 of this axle will exhibit both traction slip and brake slip, while the wheels of the front axle 11, 12 can only exhibit brake slip. Especially in the case of traction, the wheels 11, 12 of the front axle roll freely and, hence, have an angular velocity $\omega = vF/R$, while the wheels of the rear axle frequently have a higher amount because the wheel slip ωs adds to the above-mentioned amount ω. Likewise this effect has nothing to do with different angular velocities due to pressure loss in any one of the tires.

In view of the above, it is important to eliminate disturbing effects according to Figures 1A to 1C. In this respect, DE 19 721 480 A1 discloses a method wherein wheel speeds are added in pairs, the sums are brought into a relation to each other, and the value of the quotient is checked. More particularly, a method is disclosed wherein the wheel speeds of the wheels lying on a diagonal are added and the results achieved are divided. A quotient will thus be calculated which differs more or less from the ideal value 1 (constant velocity of all wheels). When especially a tire with pressure loss exists, a considerably lower value will occur either in the numerator or the denominator of the fraction so that, for this reason, the resulting quotient will also differ greatly from the ideal

value 1, upwards or downwards. Further tests may then be performed in order to detect a wheel with pressure loss, if there is one. Effects of curve geometries or traction slip are frequently compensated by considering or summing the values of diagonally opposite wheels. On the other hand, this compensation not always occurs with certainty so that comparatively wide tolerances must be chosen to avoid wrong detections. The result is that the detection occurs only at a relatively late point. During cornering maneuvers, for example, differential locks may prevent the compensation of effects due to different curve geometries. When one axle is locked, the wheels of the axle roll with the same track speed and angular velocity so that they cannot contribute to compensating the unbalance in the summation to the respective other partner.

BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to provide a method and a device for creating a correction value table, for determining a test variable, and for identifying the pressure loss in a tire of a wheel, permitting a reliable detection of pressure drop in a tire.

This object is achieved with[the features of the independent claims. Dependent claims are directed to preferred embodiments of the present invention.] a method for creating a correction value table, for determining a test variable, and for identifying the pressure loss in a tire of a vehicle, wherein the test variable is a quotient of each two sums of two wheel radii or variables mirroring these wheel radii, comprising the steps

- determining a driving dynamics variable of the vehicle, and

- determining a correction value for the test variable and storing the said in dependence on the value of the driving dynamics variable which prevailed during the correction value determination.

In the method for creating a correction value table for a test variable for identifying a pressure loss in the tire of a vehicle, individual correction values are determined for the test value and stored in dependence on the value of a driving dynamics magnitude which prevailed during or at the point of time of the correction value determination. A table of correction values is this way prepared in the course of time. The input variable of the table is the driving dynamics variable, the output value is thus a driving-dynamics responsive correction value so that the test variable for identifying a pressure loss in the tire of a vehicle can be corrected in dependence on driving dynamics.

The determination of the correction value is a learning operation. The correction value can be determined when the vehicle dynamics, in particular the driving dynamics variable satisfies defined conditions with respect to their values or with respect to their time variations, no matter whether absolute or relative. More particularly, the demand may be that the vehicle dynamics or especially the driving dynamics variable referred to has a certain constancy (within a range of values within a time window), or that the variation of driving dynamics is lower than a threshold value. The test variable may be determined from several wheel radii or quantities which correspond to these wheel radii. For example, the test variable may be a quotient of two sums of two wheel radii each.

The possible range of values of the driving dynamics variable can be subdivided into ranges. When the value of the driving

dynamics variable is represented digitally, the range division may occur already due to the digital quantization. Correction values may be determined as described hereinabove for individual or several values of the driving dynamics variable. For other values of the driving dynamics variable, correction values may be determined by interpolation with appropriate methods (linear, in general polynomial).

The driving dynamics variable may be a wheel torque and/or a curve characteristic value. The test variable may be determined from the variables of several wheels of the vehicle. In particular, it may be the quotient of two sums of such variables.

BRIEF DESCRIPTION OF THE DRAWINGS

[Individual embodiments of the present invention will be described in the following making reference to the accompanying drawings. In the drawings,]

Figures 1A to 1C	show views to explain the influence of disturbances.
Figure 2	shows representations of ideal and real variations of test variables.
Figure 3	is a block diagram of a device for creating correction value tables.
Figure 4	is a block diagram of a device for determining a test variable for the tire pressure.

Figure 5 is a device for identifying the pressure loss in a tire of a wheel.

Figure 6 is a representation for explaining physical correlations.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the embodiment of Figure 3, reference numeral 30 generally designates the device for preparing a correction value table. Said device receives sensor signals from sensors 31 and 32, and reference numeral 31 designates the four wheel sensors (one on each wheel), reference numeral 32 designates further sensors such as acceleration sensor, yaw rate sensor, steering angle sensor, transmission sensor, engine rotation sensor, and similar elements in Figure 3. In general, digital data are concerned which have already passed through various conditioning stages (conversion, filtering, standardization). The data can be tapped by a vehicle data bus 37.

Reference numeral 33 represents a first determination device for determining a driving dynamics variable. The first determination device 33 may receive especially the wheel signals and, as the case may be, further sensor signals or status variables from other control components and may determine therefrom the driving dynamics variable of the vehicle. For example, device 33 may determine a wheel torque and/or a curve characteristic value.

The first determination device 33 determines the value of the driving dynamics variable generally also as a digital variable. A range division of the maximum possible value range of the driving dynamics variable follows already due to this quantization which results from digitizing. The range division

may be more or less coarse, as desired. In the event of a curve characteristic value, it may be sufficient to select three ranges, i.e., left, straight, and right. Of course, finer gradings are also feasible. Equally the same applies when the driving dynamics variable is the drive torque. There may be embodiments where the method described is effected only in a traction case (wheel torque is greater than zero) because it may be assumed in this case that the non-driven wheels roll freely.

In another embodiment, the method is used in the unclutched case, or in the no-traction and no-braking case (wheel torque is roughly 0) when all wheels roll freely.

Reference numeral 34 represents a second determination device for determining a correction value and for storing the said in a memory 35 in dependence on the value of the driving dynamics variable which prevailed during the determination of the correction value. The second determination device 34 may also receive the wheel signals and further sensor signals. It will perform comparatively complex testing and determining operations. Device 34 itself may receive the test variable to be corrected (represented by block 36). In the second determination device 34, time variations (e.g. derivative, fluctuation within a time window) of the test variable 36 and/or the driving dynamics variable from the first determination device 33 or values of these variables can be tested as to whether they exceed threshold values or remain under them. The second determination device 34 finally determines a correction value for the test variable. The correction value is determined for a defined value of the driving dynamics variable so that it is generally demanded that the driving dynamics variable remains within the value range

considered or leaves said only briefly or only insignificantly during the determination of the correction value.

After the determination of the correction value, the said is registered in the memory 35 in dependence on the value of the driving dynamics variable. The (digital) value of the driving dynamics variable may serve as an address of the memory location or can be taken into account for the address determination. Reference numeral 38 represents a data line for the correction value, 39 refers to an address line on which the driving dynamics variable mirrors.

The individual items of the table are determined as they are available. The adjustment of the driving dynamics variable is generally achieved from the condition adjusted by the driver. A correction value is determined for the respectively prevailing value of the driving dynamics variable if the other conditions permit so. The determined correction value is then written in the corresponding table position. This way, a table is prepared in the course of time. For defined values of the driving dynamics variable, correction values can be extrapolated from determined correction values which apply to other values of the driving dynamics variable, for example, by linear or quadratic extrapolation. Extrapolated values may later be overwritten by determined values.

Correlations between a curve characteristic value and a test variable are determined and stored in one embodiment of the correction value table.

In general, the determination of correction values is a learning process wherein it is ensured also by testing conditions which are due to driving situations that only the

desired error variable but no other variables are represented in the learnt correction value.

The memory 35 may be a volatile memory whose values get lost when the current supply is switched off (deactivation of the vehicle or removal of said's battery). But the memory may also be a non-volatile memory so that the learnt values in the memory 35 survive an interruption of the current supply.

The stored correction values serve for the correction of a test variable for the tire pressure. The test variable may be so that it qualitatively furnishes a hint at the existence of a pressure loss at any one of the vehicle wheels, but does not yet give a specific hint as to which wheel actually suffers from pressure loss. More particularly, the test variable may be a variable whose value is determined from the wheel radii of at least two wheels. Instead of the wheel radii, variables mirroring these wheel radii, e.g. the wheel speeds, may be used. Several qualitatively different test variables may prevail so that also several different correction value tables would have to be created.

The test variable may be a quotient of two sums, and each sum is calculated of the wheel radii of two of the four wheels of the vehicle. The sums contain pairwise different wheel radii. One sum may be produced from the wheel radii at the front of the vehicle, and the other one may be produced from the wheel radii at the rear of the vehicle. The quotient of these two sums forms a test variable for which, as described above, in dependence on the value of the driving dynamics variable, correction values are determined in order to develop a correction value table whose input value is the value of the driving dynamics variable.

A qualitatively different test variable may be produced as a quotient of a sum of the wheel radii on the left side of the vehicle and of a sum of the wheel radii on the right side of the vehicle.

A wheel which decreases due to tire pressure loss and, consequently, rotates faster will cause a discrepancy of the resulting quotient from the standard value in all the mentioned test variables so that the tire pressure loss can be detected from this discrepancy.

The driving dynamics variable may be a wheel torque or a variable which was determined with respect to one or more wheel torques (e.g. average value, maximum, or minimum). A wheel torque can be determined with respect to an e.g. measured engine output torque and the gear ratio prevailing between engine and wheel. It is principally possible to derive the engine torque from the indexed engine torque-friction torque.

The gear ratio can be determined from the engine speed and the wheel speed. An unclutched condition is taken into account acccordingly. This information may be made available by way of a data bus, or this information may be obtained from plausibility considerations.

The friction torque of engine and transmission may also be considered in the determination of the wheel torque.

The driving dynamics variable may also be a curve characteristic value. Especially, one or more of the following variables may be taken into account in this connection: the yaw rate (angular speed about the vertical axis, from sensor or determination device), the curve radius in connection with the vehicle speed or the vehicle acceleration, the steering angle

in connection with the vehicle speed or the vehicle acceleration, the transverse acceleration (from sensor or determination device). The curve characteristic value can be determined from the wheel signals and/or from other sensor signals or signals found. The curve characteristic value can be produced redundantly. The determination of the curve characteristic values may be designed so that it primarily operates with reference to the wheel signals, however, that the determination of curve characteristic values is effected with reference to other signals, when e.g. a wheel signal is disturbed. Inasfar as the curve characteristic value is determined with reference to signals from a yaw rate sensor and/or acceleration sensor, provision must be made that backward travel of a vehicle will not cause errors. In case of need, signs must be reversed.

The preparation of the correction value table may also be made dependent on general conditions. For example, it may be made at or after defined kilometer readings. It may also take place upon the request of a driver. Generally, conditions may be chosen which prevent that actual tire pressure losses are learnt as correction factors which could cause non-detection of a tire pressure loss. On the other hand, the time variation of the individual correction values can be monitored. When a correction value changes continuously in one direction within a defined duration (e.g. during two hours) and/or within a defined distance (e.g. within 150 km), this may be an indication that an actual pressure loss is erroneously learnt as a correction value. This may then lead to an alarm.

Figures 2A to 2C show ideal and real variations of different test variables PG in dependence on different driving dynamics variables, i.e., in dependence on the curve characteristic

value KKG (Figures 2A and 2B) or in dependence on the wheel torque RM (Figure 2C).

Figure 2A shows on the left side the ideal variation of a test variable which was calculated as follows:

$$PG = \frac{r11 + r14}{r12 + r13}$$

wherein the values r are wheel radii or corresponding values (e.g., angular velocity, and it must then be considered that they behave inversely to the radii), and the numerals are assigned to identify the individual wheels corresponding to the reference numerals in Figure 1A. In the ideal variation (left), the test variable PG adopts the value 1 with a curve characteristic value 0 (straight travel) because ideally all wheels rotate equally quickly at like wheel radii so that numerator and denominator adopt the same value and said's quotient adopts the value 1. However, the real variation is different for most various reasons, and namely both with respect to the zero point and with respect to the gradient. The latter is illustrated on the right in Figure 2A. The test variable no longer runs through point 0/1, for example, due to differently worn tires or an unsymmetrical vehicle loading, and also the gradient may be different. It is principally pointed out that the curve characteristic value is represented only qualitatively. The variation does not have to be similar to a straight line. However, a monotonous behavior (rising or declining) must be expected over the curve characteristic value which eventually mirrors the different wheel speeds due to the geometrical correlations explained in Figure 1A.

Figure 2B shows the ideal and real variation of the test variable PG which was determined as follows:

$$PG = \frac{r11 + r13}{r12 + r14}$$

In this case, the values of the diagonals were respectively added and the sums are calculated to form the quotient. In the ideal variation (Figure 2B left), the different geometry conditions are neutralized so that a straight course through the point 1 on the ordinate would have to be expected. In this case, too, other real variations will be caused due to different disturbances which are not due to pressure losses. One example is shown on the right in Figure 2B. Again, the test variable does not run through the point 0/1 and may have a determined gradient also in this case, and again it must be pointed out once more that it is not necessarily a straight line that represents the correct variation of the test variable.

Figure 2C shows the variation of the test variable PG in dependence on the wheel torque, and the test variable was determined as follows:

$$PG = \frac{r11 + r12}{r13 + r14}$$

Inasfar as only the traction case (wheel torque is considered as positive) is looked at, a characteristic curve variation results only for positive wheel torques. In the ideal variation (Figure 2C left) the value 1 results for the wheel torque 0 because then all wheels with the same radius run freely and, thus, equally quickly so that identical values are achieved in the numerator and the denominator of the fraction. Herein, too, discrepancies may occur in the real case (Figure 2C right). In

the non-traction case, the value is not required to be at zero, and also the further variation (e.g. the gradient of a straight line) may be different (see Figure 2C right). In an overrun condition, a characteristic curve variation occurs only for negative wheel torques.

The real variations shown on the right side in Figures 2A to 2C show discrepancies from the ideal variation which take place due to secondary disturbances of most different causes (worn tires, unsymmetrical loading condition of the vehicle), which apart from the primary disturbances (curve geometry, rolling moment, traction slip) may cause discrepancies of the test variable from the ideal variation which have nothing to do with a pressure loss in a tire that will possibly be detected. These further coefficients of influence are eliminated by learning the correction values.

Figure 4 shows a device for determining a test variable for the tire pressure in the tires of a vehicle. It includes a preparation device 30 for preparing a correction value table, stored in memory 35 for the test variable. The preparation device 30 can be designed as described hereinabove or as illustrated in Figure 3. Further, the test variable determination device includes a second determination device 41 for determining a driving dynamics variable. This variable is that driving dynamics variable which is required as an input quantity for the correction value table stored in memory 35. The second determination device 41 may be the same as the first determination device 33.

A third determination device 42 determines the driving dynamics variable in a conventional fashion, for example, by determining the variable with reference to the wheel radii of several

wheels. Methods known in the art may be used for this purpose. The quotients described above can be calculated from sums.

A reading device 43 reads a correction value from the correction value table in the memory 35 in accordance with the driving dynamics variable determined in the second determination device 41.

A correction device 44 corrects the value of the test variable determined by the second determination device 41. The correction value may be an additive value or a factor by which the determined value is added or multiplied. When the test variable is the quotient of two 'symmetric' sums, the ideal value amounts to 1. A real value can differ therefrom and e.g. amount to 0.97. By using the correction value, the value of the test variable would be caused to reach e.g. 1.00 again.

Figure 5 shows a device for identifying the pressure loss in a tire of a wheel. The identification device includes a determination device 40 for determining a test variable for the tire pressure. The determination device can be designed as described hereinabove and especially as shown schematically in Figure 4. It determines a corrected test variable, and the said test variable is determined with reference to wheel radii of several wheels of the vehicle.

Besides, the identification device includes a comparison device 51 which compares the corrected test variable with one or more threshold values. A discrepancy which still exists after the correction would be an indication that either the numerator or the denominator of the fraction due to pressure loss shows a changed value so that, accordingly, the quotient changes as well. Because the change may be in the numerator or in the denominator, the test variable can be tested with respect to

whether it exceeds a top threshold value that lies above the standard value and with respect to whether it remains under a bottom threshold value that lies below the standard value. The threshold values are represented by reference numeral 55. In these threshold value tests, too, time considerations may be performed to prevent that single runaways of the corrected test variable will cause wrong identifications. Likewise the test variable itself (corrected or not corrected) may still be subject to processing operations, for example, filtering or smoothing e.g. by low-pass filtering or averaging over a time window. The time consideration during the threshold value test which is performed in a characteristic curve device 53 may comprise the checking operation whether the 'runaway condition' lasts longer than a defined duration or, within a defined first period, lasts longer than a defined shorter second period in total.

When finally the result is that the test variable has reached or passed a threshold value, this is a first indication of the existence of pressure loss. Inasfar as the test variable is determined with reference to the wheel radii of several wheels of the vehicle, this test does not yet permit gathering which wheel actually suffers from the pressure loss. However, it can be concluded from the information about whether the variable has exceeded the top threshold value or remained under the bottom threshold value which wheel pair suffers from pressure loss. As the case may be, a qualitatively different test variable may then be used to determine the exact wheel where pressure loss prevails.

Both the determination of correction values and the determination of test variables and the pressure loss identification may be effected speed-responsively. The vehicle

speed may thus be another table input when the correction value table is prepared.

When the result of a checking operation is that the test variable has reached or passed a threshold value, this can be considered as a first assumption of pressure loss. The further procedure may be that, based on this assumption, the test threshold values are changed by way of a modification device 54 so that the pressure loss identification is less sensitive. If then, preferably within a determined time or path window, the modified threshold value is again reached or passed, pressure loss identification is affirmed, and an alarm is triggered.

If the curve characteristic value is a wheel torque, the test variable may be the quotient of the sum of the wheel radii at the front and the sum of the wheel radii at the rear axle. With the first assumption of a pressure loss, the threshold values can be influenced so that the threshold values on the driven axle are modified differently for further identification operations than those on the non-driven axle. The modification may also be effected in dependence on the wheel torque and/or the gear step of the vehicle.

[Abstract:]

Method and Device for Creating a Compensation Value Table, for Determining a Test Variable, and for Identifying the Pressure Loss in a Tire of a Wheel

ABSTRACT OF THE DISCLOSURE

A method for creating a correction value table for a test variable for identifying the pressure loss in a tire of a vehicle comprises the steps of determining a driving dynamics variable of the vehicle, determining a correction value for the test variable, and storing the said in dependence on the value of the driving dynamics variable that prevailed during the correction value determination. A method of determining a corrected test variable for identifying a pressure loss in the tire of a vehicle comprises the steps of determining a test variable from the wheel radii or from variables that mirror these wheel radii of at least two wheels, preparing a correction value table by means of the method as described hereinabove, determining a driving dynamics variable of the vehicle, reading out of a correction value from the table in accordance with the value of the driving dynamics variable, and correcting the test variable by means of the correction value. A method of identifying the pressure loss in a tire of a wheel comprises the steps of determining a test variable for identifying the pressure loss in the tire of a vehicle by means of the method as described hereinabove, comparing the test variable with a threshold value, and identifying a pressure loss when the test variable reaches or passes the threshold value.

[(Figure 3)]

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Method and Device for Creating a Compensation Value Table, for Determining a Test Variable, and for Identifying the Pressure Loss in a Tire of a Wheel

The present invention relates to a method and a device for creating a correction value table, for determining a test variable, and for identifying the pressure loss in a tire of a wheel according to the preambles of the independent claims. A method for identifying pressure loss of this type is disclosed in DE 19 721 480 A1.

Basic physical correlations are explained by way of Figure 6. Reference numeral 61 represents a regular wheel on the roadway 60. The wheel center 63 moves with the vehicle chassis and, thus, at the vehicle speed Vf. Corresponding to the generally accepted relationship between the track speed v of a point on a disc rotating with the angular speed ω, with the said point being spaced from the center of rotation by the radius R, i.e., $\omega = v/R$, $\omega r = vF/Rr$ results on the left side of Figure 6. The angular velocity ω of vehicle wheels can be determined by means of wheel sensors, while the vehicle speed v generally cannot be sensed by sensors. The dynamic rolling circumference of a wheel varies in the event of pressure loss. The wheel rotates faster compared to the normal condition or compared to the wheel without pressure loss.

Additional effects can influence the angular velocities of the wheels, but the resulting difference between the angular velocities of individual wheels would not indicate pressure loss in any one of the wheels. Examples herefor are traction slip, different geometries during cornering, unsymmetrical load

distribution in the vehicle, or similar factors. Two effects which result drom driving dynamics, especially during cornering or in the traction case, will be explained referring to Figures 1A to 1C.

Figure 1A shows a vehicle 10 with left front wheel 11, right front wheel 12, right rear wheel 13, and left rear wheel 14. The vehicle rides at a speed vF in a curve to the right, and it is assumed that the vehicle's point of gravity S follows the radius R about the center M. The wheels 12 and 13 on the right-hand side of the vehicle roll on the inner track and, therefore, have a track with approximately the same smaller inside radius Ri, while the wheels 11 and 14 on the left-hand side of the vehicle roll on the outer track and, hence, ride in a curve with the larger outside radius Ra. Because they have to cover a larger distance in the same time, the curve-outward wheels 11 and 14 exhibit a higher track speed and, thus, also a higher angular velocity than the curve-inward wheels 12 and 13. However, these differences are not due to a pressure loss in any one of the wheels.

Another effect is explained with reference to Figure 1B. The vehicle shown in Figure 1A is shown from the back, it follows the same track as the vehicle shown in Figure 1A (curve to the right, i.e., to the right into the drawing plane in Figure 1B) about the center M with radius R. A centrifugal force Fz which is applied to the vehicle point of gravity S is produced due to the cornering maneuver. The counterforce is the friction force Fr between the vehicle wheels and the roadway. Because these forces do not act in the same plane, a rolling moment Mr is produced in the mentioned situation counterclockwise about the longitudinal axis of the vehicle. This brings about that the curve-outward wheels 11 and 14 are subjected to greater stress than the curve-inward wheels 12 and 13. The result is that they

are more compressed, hence show a smaller dynamic rolling radius and a higher angular velocity. The effect of Figure 1B points to the same direction as the one described by way of Figure 1A so that they add.

Figure 1C shows a situation in which the vehicle 10 moves on the roadway 15 driven by engine 16. In the example of Figure 1 the rear axle is driven so that the wheels 13, 14 of this axle will exhibit both traction slip and brake slip, while the wheels of the front axle 11, 12 can only exhibit brake slip. Especially in the case of traction, the wheels 11, 12 of the front axle roll freely and, hence, have an angular velocity $\omega = vF/R$, while the wheels of the rear axle frequently have a higher amount because the wheel slip ωs adds to the above-mentioned amount ω. Likewise this effect has nothing to do with different angular velocities due to pressure loss in any one of the tires.

In view of the above, it is important to eliminate disturbing effects according to Figures 1A to 1C. In this respect, DE 19 721 480 A1 discloses a method wherein wheel speeds are added in pairs, the sums are brought into a relation to each other, and the value of the quotient is checked. More particularly, a method is disclosed wherein the wheel speeds of the wheels lying on a diagonal are added and the results achieved are divided. A quotient will thus be calculated which differs more or less from the ideal value 1 (constant velocity of all wheels). When especially a tire with pressure loss exists, a considerably lower value will occur either in the numerator or the denominator of the fraction so that, for this reason, the resulting quotient will also differ greatly from the ideal value 1, upwards or downwards. Further tests may then be performed in order to detect a wheel with pressure loss, if there is one. Effects of curve geometries or traction slip are

frequently compensated by considering or summing the values of diagonally opposite wheels. On the other hand, this compensation not always occurs with certainty so that comparatively wide tolerances must be chosen to avoid wrong detections. The result is that the detection occurs only at a relatively late point. During cornering maneuvers, for example, differential locks may prevent the compensation of effects due to different curve geometries. When one axle is locked, the wheels of the axle roll with the same track speed and angular velocity so that they cannot contribute to compensating the unbalance in the summation to the respective other partner.

An object of the present invention is to provide a method and a device for creating a correction value table, for determining a test variable, and for identifying the pressure loss in a tire of a wheel, permitting a reliable detection of pressure drop in a tire.

This object is achieved with the features of the independent claims. Dependent claims are directed to preferred embodiments of the present invention.

In the method for creating a correction value table for a test variable for identifying a pressure loss in the tire of a vehicle, individual correction values are determined for the test value and stored in dependence on the value of a driving dynamics magnitude which prevailed during or at the point of time of the correction value determination. A table of correction values is this way prepared in the course of time. The input variable of the table is the driving dynamics variable, the output value is thus a driving-dynamics responsive correction value so that the test variable for identifying a pressure loss in the tire of a vehicle can be corrected in dependence on driving dynamics.

The determination of the correction value is a learning operation. The correction value can be determined when the vehicle dynamics, in particular the driving dynamics variable satisfies defined conditions with respect to their values or with respect to their time variations, no matter whether absolute or relative. More particularly, the demand may be that the vehicle dynamics or especially the driving dynamics variable referred to has a certain constancy (within a range of values within a time window), or that the variation of driving dynamics is lower than a threshold value. The test variable may be determined from several wheel radii or quantities which correspond to these wheel radii. For example, the test variable may be a quotient of two sums of two wheel radii each.

The possible range of values of the driving dynamics variable can be subdivided into ranges. When the value of the driving dynamics variable is represented digitally, the range division may occur already due to the digital quantization. Correction values may be determined as described hereinabove for individual or several values of the driving dynamics variable. For other values of the driving dynamics variable, correction values may be determined by interpolation with appropriate methods (linear, in general polynomial).

The driving dynamics variable may be a wheel torque and/or a curve characteristic value. The test variable may be determined from the variables of several wheels of the vehicle. In particular, it may be the quotient of two sums of such variables.

Individual embodiments of the present invention will be described in the following making reference to the accompanying drawings. In the drawings,

Figures 1A to 1C show views to explain the influence of disturbances.

Figure 2 shows representations of ideal and real variations of test variables.

Figure 3 is a block diagram of a device for creating correction value tables.

Figure 4 is a block diagram of a device for determining a test variable for the tire pressure.

Figure 5 is a device for identifying the pressure loss in a tire of a wheel.

Figure 6 is a representation for explaining physical correlations.

In the embodiment of Figure 3, reference numeral 30 generally designates the device for preparing a correction value table. Said device receives sensor signals from sensors 31 and 32, and reference numeral 31 designates the four wheel sensors (one on each wheel), reference numeral 32 designates further sensors such as acceleration sensor, yaw rate sensor, steering angle sensor, transmission sensor, engine rotation sensor, and similar elements in Figure 3. In general, digital data are concerned which have already passed through various conditioning stages (conversion, filtering, standardization). The data can be tapped by a vehicle data bus 37.

Reference numeral 33 represents a first determination device for determining a driving dynamics variable. The first

determination device 33 may receive especially the wheel signals and, as the case may be, further sensor signals or status variables from other control components and may determine therefrom the driving dynamics variable of the vehicle. For example, device 33 may determine a wheel torque and/or a curve characteristic value.

The first determination device 33 determines the value of the driving dynamics variable generally also as a digital variable. A range division of the maximum possible value range of the driving dynamics variable follows already due to this quantization which results from digitizing. The range division may be more or less coarse, as desired. In the event of a curve characteristic value, it may be sufficient to select three ranges, i.e., left, straight, and right. Of course, finer gradings are also feasible. Equally the same applies when the driving dynamics variable is the drive torque. There may be embodiments where the method described is effected only in a traction case (wheel torque is greater than zero) because it may be assumed in this case that the non-driven wheels roll freely.

In another embodiment, the method is used in the unclutched case, or in the no-traction and no-braking case (wheel torque is roughly 0) when all wheels roll freely.

Reference numeral 34 represents a second determination device for determining a correction value and for storing the said in a memory 35 in dependence on the value of the driving dynamics variable which prevailed during the determination of the correction value. The second determination device 34 may also receive the wheel signals and further sensor signals. It will perform comparatively complex testing and determining operations. Device 34 itself may receive the test variable to

be corrected (represented by block 36). In the second determination device 34, time variations (e.g. derivative, fluctuation within a time window) of the test variable 36 and/or the driving dynamics variable from the first determination device 33 or values of these variables can be tested as to whether they exceed threshold values or remain under them. The second determination device 34 finally determines a correction value for the test variable. The correction value is determined for a defined value of the driving dynamics variable so that it is generally demanded that the driving dynamics variable remains within the value range considered or leaves said only briefly or only insignificantly during the determination of the correction value.

After the determination of the correction value, the said is registered in the memory 35 in dependence on the value of the driving dynamics variable. The (digital) value of the driving dynamics variable may serve as an address of the memory location or can be taken into account for the address determination. Reference numeral 38 represents a data line for the correction value, 39 refers to an address line on which the driving dynamics variable mirrors.

The individual items of the table are determined as they are available. The adjustment of the driving dynamics variable is generally achieved from the condition adjusted by the driver. A correction value is determined for the respectively prevailing value of the driving dynamics variable if the other conditions permit so. The determined correction value is then written in the corresponding table position. This way, a table is prepared in the course of time. For defined values of the driving dynamics variable, correction values can be extrapolated from determined correction values which apply to other values of the driving dynamics variable, for example, by linear or quadratic

extrapolation. Extrapolated values may later be overwritten by determined values.

Correlations between a curve characteristic value and a test variable are determined and stored in one embodiment of the correction value table.

In general, the determination of correction values is a learning process wherein it is ensured also by testing conditions which are due to driving situations that only the desired error variable but no other variables are represented in the learnt correction value.

The memory 35 may be a volatile memory whose values get lost when the current supply is switched off (deactivation of the vehicle or removal of said's battery). But the memory may also be a non-volatile memory so that the learnt values in the memory 35 survive an interruption of the current supply.

The stored correction values serve for the correction of a test variable for the tire pressure. The test variable may be so that it qualitatively furnishes a hint at the existence of a pressure loss at any one of the vehicle wheels, but does not yet give a specific hint as to which wheel actually suffers from pressure loss. More particularly, the test variable may be a variable whose value is determined from the wheel radii of at least two wheels. Instead of the wheel radii, variables mirroring these wheel radii, e.g. the wheel speeds, may be used. Several qualitatively different test variables may prevail so that also several different correction value tables would have to be created.

The test variable may be a quotient of two sums, and each sum is calculated of the wheel radii of two of the four wheels of

the vehicle. The sums contain pairwise different wheel radii. One sum may be produced from the wheel radii at the front of the vehicle, and the other one may be produced from the wheel radii at the rear of the vehicle. The quotient of these two sums forms a test variable for which, as described above, in dependence on the value of the driving dynamics variable, correction values are determined in order to develop a correction value table whose input value is the value of the driving dynamics variable.

A qualitatively different test variable may be produced as a quotient of a sum of the wheel radii on the left side of the vehicle and of a sum of the wheel radii on the right side of the vehicle.

A wheel which decreases due to tire pressure loss and, consequently, rotates faster will cause a discrepancy of the resulting quotient from the standard value in all the mentioned test variables so that the tire pressure loss can be detected from this discrepancy.

The driving dynamics variable may be a wheel torque or a variable which was determined with respect to one or more wheel torques (e.g. average value, maximum, or minimum). A wheel torque can be determined with respect to an e.g. measured engine output torque and the gear ratio prevailing between engine and wheel. It is principally possible to derive the engine torque from the indexed engine torque-friction torque.

The gear ratio can be determined from the engine speed and the wheel speed. An unclutched condition is taken into account acccordingly. This information may be made available by way of a data bus, or this information may be obtained from plausibility considerations.

The friction torque of engine and transmission may also be considered in the determination of the wheel torque.

The driving dynamics variable may also be a curve characteristic value. Especially, one or more of the following variables may be taken into account in this connection: the yaw rate (angular speed about the vertical axis, from sensor or determination device), the curve radius in connection with the vehicle speed or the vehicle acceleration, the steering angle in connection with the vehicle speed or the vehicle acceleration, the transverse acceleration (from sensor or determination device). The curve characteristic value can be determined from the wheel signals and/or from other sensor signals or signals found. The curve characteristic value can be produced redundantly. The determination of the curve characteristic values may be designed so that it primarily operates with reference to the wheel signals, however, that the determination of curve characteristic values is effected with reference to other signals, when e.g. a wheel signal is disturbed. Inasfar as the curve characteristic value is determined with reference to signals from a yaw rate sensor and/or acceleration sensor, provision must be made that backward travel of a vehicle will not cause errors. In case of need, signs must be reversed.

The preparation of the correction value table may also be made dependent on general conditions. For example, it may be made at or after defined kilometer readings. It may also take place upon the request of a driver. Generally, conditions may be chosen which prevent that actual tire pressure losses are learnt as correction factors which could cause non-detection of a tire pressure loss. On the other hand, the time variation of the individual correction values can be monitored. When a

correction value changes continuously in one direction within a defined duration (e.g. during two hours) and/or within a defined distance (e.g. within 150 km), this may be an indication that an actual pressure loss is erroneously learnt as a correction value. This may then lead to an alarm.

Figures 2A to 2C show ideal and real variations of different test variables PG in dependence on different driving dynamics variables, i.e., in dependence on the curve characteristic value KKG (Figures 2A and 2B) or in dependence on the wheel torque RM (Figure 2C).

Figure 2A shows on the left side the ideal variation of a test variable which was calculated as follows:

$$PG = \frac{r11 + r14}{r12 + r13}$$

wherein the values r are wheel radii or corresponding values (e.g., angular velocity, and it must then be considered that they behave inversely to the radii), and the numerals are assigned to identify the individual wheels corresponding to the reference numerals in Figure 1A. In the ideal variation (left), the test variable PG adopts the value 1 with a curve characteristic value 0 (straight travel) because ideally all wheels rotate equally quickly at like wheel radii so that numerator and denominator adopt the same value and said's quotient adopts the value 1. However, the real variation is different for most various reasons, and namely both with respect to the zero point and with respect to the gradient. The latter is illustrated on the right in Figure 2A. The test variable no longer runs through point 0/1, for example, due to differently worn tires or an unsymmetrical vehicle loading, and also the gradient may be different. It is principally pointed

out that the curve characteristic value is represented only qualitatively. The variation does not have to be similar to a straight line. However, a monotonous behavior (rising or declining) must be expected over the curve characteristic value which eventually mirrors the different wheel speeds due to the geometrical correlations explained in Figure 1A.

Figure 2B shows the ideal and real variation of the test variable PG which was determined as follows:

$$PG = \frac{r11 + r13}{r12 + r14}$$

In this case, the values of the diagonals were respectively added and the sums are calculated to form the quotient. In the ideal variation (Figure 2B left), the different geometry conditions are neutralized so that a straight course through the point 1 on the ordinate would have to be expected. In this case, too, other real variations will be caused due to different disturbances which are not due to pressure losses. One example is shown on the right in Figure 2B. Again, the test variable does not run through the point 0/1 and may have a determined gradient also in this case, and again it must be pointed out once more that it is not necessarily a straight line that represents the correct variation of the test variable.

Figure 2C shows the variation of the test variable PG in dependence on the wheel torque, and the test variable was determined as follows:

$$PG = \frac{r11 + r12}{r13 + r14}$$

Inasfar as only the traction case (wheel torque is considered as positive) is looked at, a characteristic curve variation results only for positive wheel torques. In the ideal variation (Figure 2C left) the value 1 results for the wheel torque 0 because then all wheels with the same radius run freely and, thus, equally quickly so that identical values are achieved in the numerator and the denominator of the fraction. Herein, too, discrepancies may occur in the real case (Figure 2C right): In the non-traction case, the value is not required to be at zero, and also the further variation (e.g. the gradient of a straight line) may be different (see Figure 2C right). In an overrun condition, a characteristic curve variation occurs only for negative wheel torques.

The real variations shown on the right side in Figures 2A to 2C show discrepancies from the ideal variation which take place due to secondary disturbances of most different causes (worn tires, unsymmetrical loading condition of the vehicle), which apart from the primary disturbances (curve geometry, rolling moment, traction slip) may cause discrepancies of the test variable from the ideal variation which have nothing to do with a pressure loss in a tire that will possibly be detected. These further coefficients of influence are eliminated by learning the correction values.

Figure 4 shows a device for determining a test variable for the tire pressure in the tires of a vehicle. It includes a preparation device 30 for preparing a correction value table, stored in memory 35 for the test variable. The preparation device 30 can be designed as described hereinabove or as illustrated in Figure 3. Further, the test variable determination device includes a second determination device 41 for determining a driving dynamics variable. This variable is

that driving dynamics variable which is required as an input quantity for the correction value table stored in memory 35. The second determination device 41 may be the same as the first determination device 33.

A third determination device 42 determines the driving dynamics variable in a conventional fashion, for example, by determining the variable with reference to the wheel radii of several wheels. Methods known in the art may be used for this purpose. The quotients described above can be calculated from sums.

A reading device 43 reads a correction value from the correction value table in the memory 35 in accordance with the driving dynamics variable determined in the second determination device 41.

A correction device 44 corrects the value of the test variable determined by the second determination device 41. The correction value may be an additive value or a factor by which the determined value is added or multiplied. When the test variable is the quotient of two 'symmetric' sums, the ideal value amounts to 1. A real value can differ therefrom and e.g. amount to 0.97. By using the correction value, the value of the test variable would be caused to reach e.g. 1.00 again.

Figure 5 shows a device for identifying the pressure loss in a tire of a wheel. The identification device includes a determination device 40 for determining a test variable for the tire pressure. The determination device can be designed as described hereinabove and especially as shown schematically in Figure 4. It determines a corrected test variable, and the said test variable is determined with reference to wheel radii of several wheels of the vehicle.

Besides, the identification device includes a comparison device 51 which compares the corrected test variable with one or more threshold values. A discrepancy which still exists after the correction would be an indication that either the numerator or the denominator of the fraction due to pressure loss shows a changed value so that, accordingly, the quotient changes as well. Because the change may be in the numerator or in the denominator, the test variable can be tested with respect to whether it exceeds a top threshold value that lies above the standard value and with respect to whether it remains under a bottom threshold value that lies below the standard value. The threshold values are represented by reference numeral 55. In these threshold value tests, too, time considerations may be performed to prevent that single runaways of the corrected test variable will cause wrong identifications. Likewise the test variable itself (corrected or not corrected) may still be subject to processing operations, for example, filtering or smoothing e.g. by low-pass filtering or averaging over a time window. The time consideration during the threshold value test which is performed in a characteristic curve device 53 may comprise the checking operation whether the 'runaway condition' lasts longer than a defined duration or, within a defined first period, lasts longer than a defined shorter second period in total.

When finally the result is that the test variable has reached or passed a threshold value, this is a first indication of the existence of pressure loss. Inasfar as the test variable is determined with reference to the wheel radii of several wheels of the vehicle, this test does not yet permit gathering which wheel actually suffers from the pressure loss. However, it can be concluded from the information about whether the variable has exceeded the top threshold value or remained under the bottom threshold value which wheel pair suffers from pressure

loss. As the case may be, a qualitatively different test variable may then be used to determine the exact wheel where pressure loss prevails.

Both the determination of correction values and the determination of test variables and the pressure loss identification may be effected speed-responsively. The vehicle speed may thus be another table input when the correction value table is prepared.

When the result of a checking operation is that the test variable has reached or passed a threshold value, this can be considered as a first assumption of pressure loss. The further procedure may be that, based on this assumption, the test threshold values are changed by way of a modification device 54 so that the pressure loss identification is less sensitive. If then, preferably within a determined time or path window, the modified threshold value is again reached or passed, pressure loss identification is affirmed, and an alarm is triggered.

If the curve characteristic value is a wheel torque, the test variable may be the quotient of the sum of the wheel radii at the front and the sum of the wheel radii at the rear axle. With the first assumption of a pressure loss, the threshold values can be influenced so that the threshold values on the driven axle are modified differently for further identification operations than those on the non-driven axle. The modification may also be effected in dependence on the wheel torque and/or the gear step of the vehicle.

Patent Claims:

1. Method for creating a correction value table, for determining a test variable, and for identifying the pressure loss in a tire of a vehicle,

   c h a r a c t e r i z e d by the steps of

   - determining a driving dynamics variable of the vehicle, and

   - determining a correction value for the test variable and storing the said in dependence on the value of the driving dynamics variable which prevailed during the correction value determination.

2. Method as claimed in claim 1, c h a r a c t e r i z e d in that the correction value determination takes place only when the vehicle dynamics with respect to their values and/or their time variations satisfies defined conditions.

3. Method as claimed in claim 2, c h a r a c t e r i z e d in that the correction value determination or storage takes place only when the vehicle dynamics has remained within a defined value range for a defined period of time.

4. Method as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that the test variable is determined from the wheel radii or from variables mirroring these wheel radii of at least two wheels.

5. Method as claimed in claim 4, c h a r a c t e r i z e d in that the test variable is a quotient of each two sums of two wheel radii or variables mirroring these wheel radii.

6. Method as claimed in claim 5, c h a r a c t e r i z e d in that one sum is produced with reference to variables on front wheels of the vehicle and the other sum is produced with reference to variables on rear wheels of the vehicle.

7. Method as claimed in claim 5 or 6, c h a r a c t e r i z e d in that one sum is produced with reference to variables on wheels of the right vehicle side and the other sum is produced with reference to variables on wheels of the left vehicle side.

8. Method as claimed in any one of claims 5 to 7, c h a r a c t e r i z e d in that one sum is produced with reference to variables on the wheels on the one vehicle diagonal and the other sum is produced with reference to variables on wheels of the other vehicle diagonal.

9. Method as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that correction values are determined for several values of the driving dynamics variable, and correction values are extrapolated from the determined correction values for other values of the driving dynamics variable.

10. Method as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that the driving dynamics variable is a wheel torque which is determined from the engine torque and the gear ratio.

11. Method as claimed in claim 10, c h a r a c t e r i z e d in that the gear ratio is determined from the engine speed and the wheel speed.

12. Method as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that the driving dynamics variable is a curve characteristic value acquired during cornering maneuvers.

13. Method as claimed in claim 12, c h a r a c t e r i z e d in that as the curve characteristic value, one or more of the following variables can be taken into account:

- the yaw rate, also in connection with the vehicle speed or acceleration,

- the curve radius in connection with the vehicle speed or the vehicle acceleration,

- the steering angle in connection with the vehicle speed or the vehicle acceleration,

- the transverse acceleration, also in connection with the vehicle speed or acceleration.

14. Method as claimed in claim 13,
    c h a r a c t e r i z e d in that the correction value is stored in dependence on several curve characteristic values.

15. Method of determining a corrected test variable for identifying a pressure loss in the tires of a vehicle, comprising the steps of

    - determining a test variable from the wheel radii or from variables mirroring these wheel radii of at least two wheels,

    c h a r a c t e r i z e d by the steps of

    - preparing a correction value table by means of the method as claimed in any one of claims 1 to 14,

    - determining a driving dynamics variable of the vehicle,

    - reading a correction value from the table in accordance with the value of the driving dynamics variable, and

    - correcting the test variable by means of the correction value.

16. Method of determining a corrected test variable for identifying a pressure loss in the tires of a vehicle, comprising the steps of

- determining a test variable from the wheel radii or from variables mirroring these wheel radii of at least two wheels,

c h a r a c t e r i z e d by the steps of

- preparing a correction value table by means of the method as claimed in any one of claims 1 to 14,

- determining a driving dynamics variable of the vehicle,

- reading a correction value from the table in accordance with the value of the driving dynamics variable, and

- directly comparing the test variable with reference values which are determined in dependence on the driving dynamics variable and stored in the table.

17. Method as claimed in claim 16,
c h a r a c t e r i z e d in that the determination of test variables is effected with the features which are named directly in any one of claims 4 to 8.

18. Method of identifying the pressure loss in a tire of a wheel,

c h a r a c t e r i z e d by the steps of

- determining a test variable for identifying pressure loss in the tire of a vehicle by means of the method as claimed in claim 15 or 16,

- comparing the test variable with a threshold value, and

- identifying pressure loss when the test variable reaches or passes the threshold value.

19. Method as claimed in claim 18, c h a r a c t e r i z e d in that when pressure loss is assumed at any one of the driven wheels, the threshold value is modified so that the pressure loss identification becomes more sensitive.

20. Device (30) for preparing a correction value table for a test variable for identifying the pressure loss in the tire of a vehicle, preferably for implementing the method as claimed in any one of claims 1 to 14,

    c h a r a c t e r i z e d by

    - a first determination device (33) for determining a driving dynamics variable of the vehicle, and

    - a second determination device (34) for determining a correction value and storing the said in a memory (35) in dependence on the value of the driving dynamics variable which prevailed during the determination of the correction value.

21. Device for determining a corrected test variable for the pressure in the tires of a vehicle, preferably for implementing the method as claimed in any one of claims 15 to 17, including

    - a second determination device (41) for determining a test variable for the tire pressure,

c h a r a c t e r i z e d by

- a preparation device (30) for preparing a correction value table (35) for a test variable as claimed in claim 19,

- a third determination device (42) for determining the driving dynamics variable,

- a reading device (43) for reading out a correction value in accordance with the driving dynamics variable from the table (35), and

- a correction device (44) for correcting the test variable in accordance with the read-out correction value.

22. Device for identifying the pressure loss in a tire of a wheel, preferably for implementing the method as claimed in claim 18 or 19,

c h a r a c t e r i z e d by

- a determination device (40) for determining a test variable for the tire pressure in the tires of a vehicle as claimed in claim 20,

- a comparison device (51) for comparing the test variable with a threshold value, and

- an identification device (53) for identifying a pressure loss when the test variable reaches or passes the threshold value.

23. Device as claimed in claim 22,
c h a r a c t e r i z e d by a modification device (54) which changes the threshold value accordingly when a pressure loss is assumed.

Fig. 1A

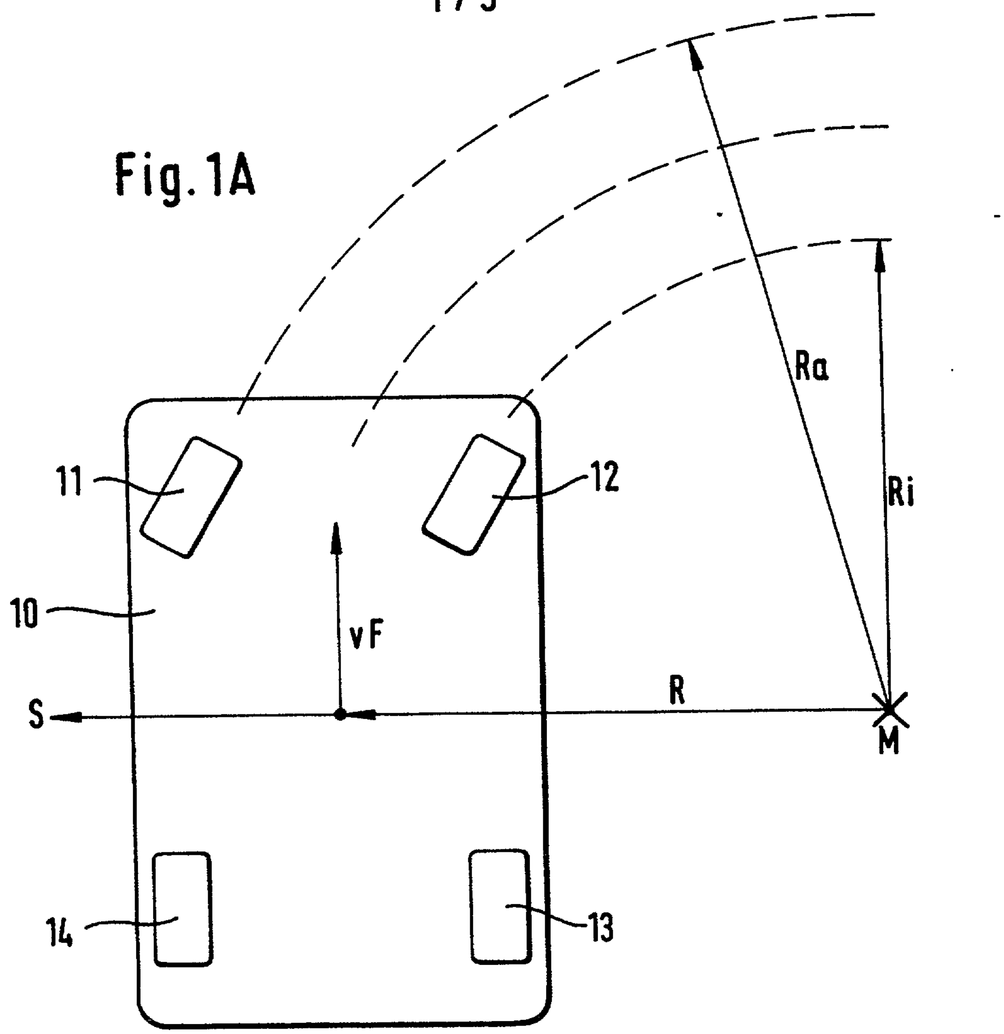


Fig. 1B

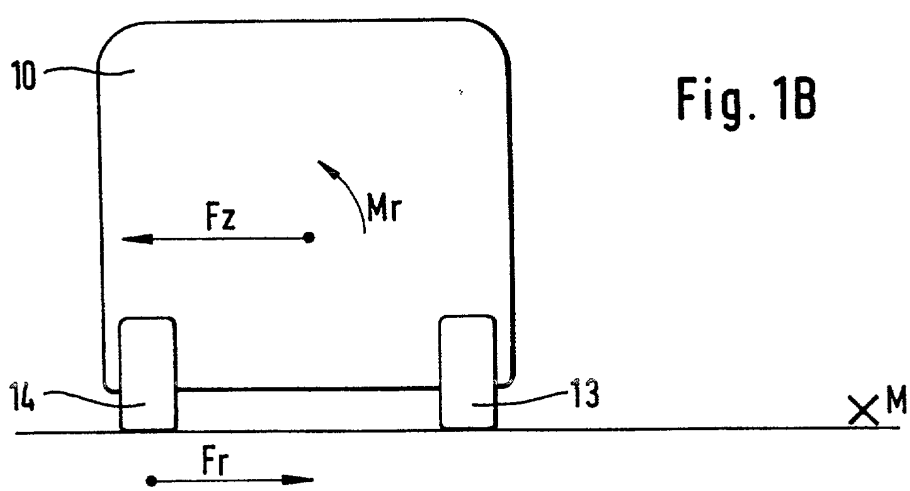


Fig.1C

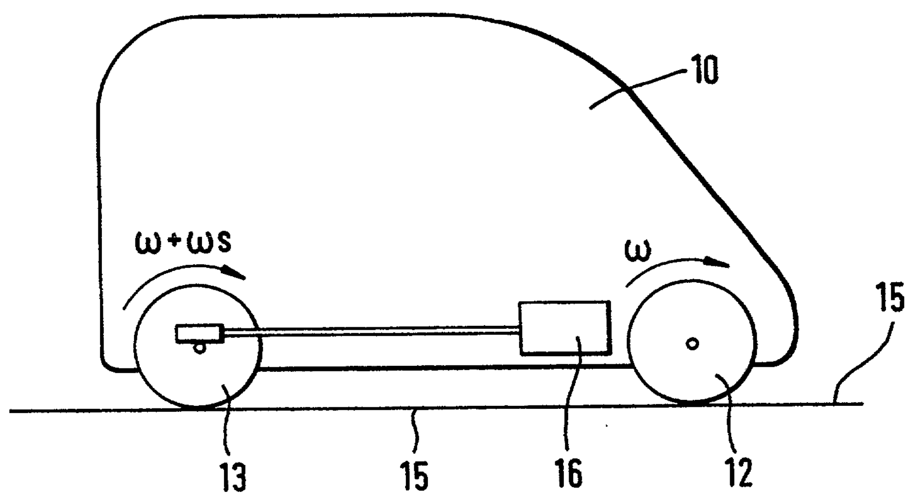


Fig. 2A

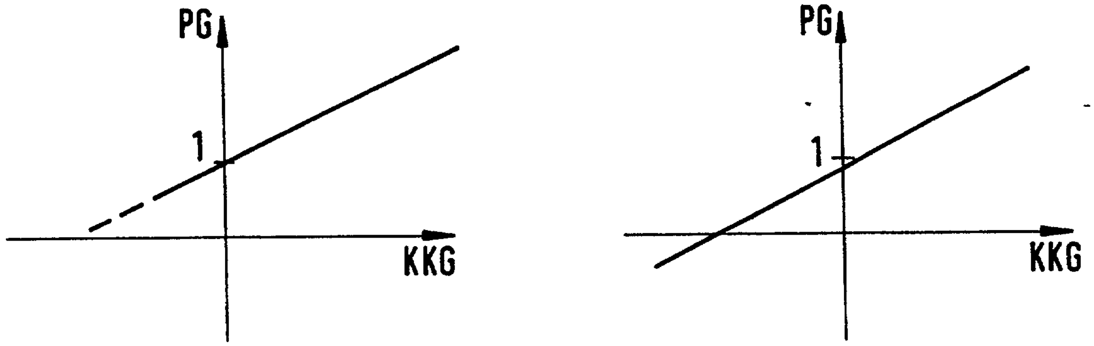


Fig. 2B

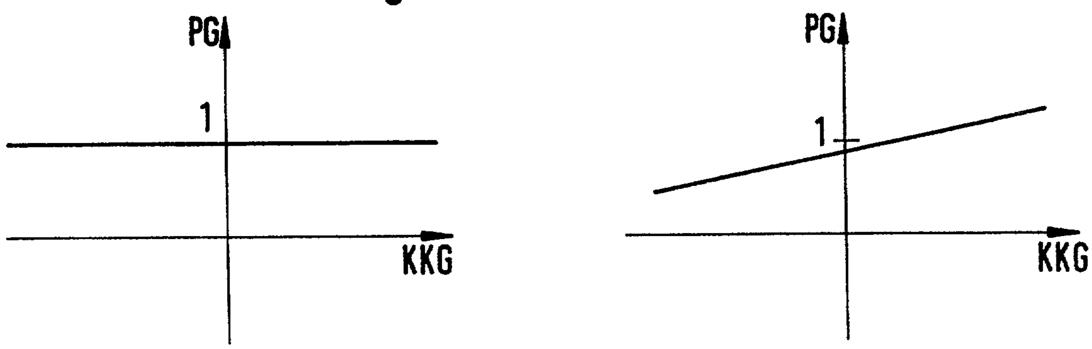


Fig. 2C

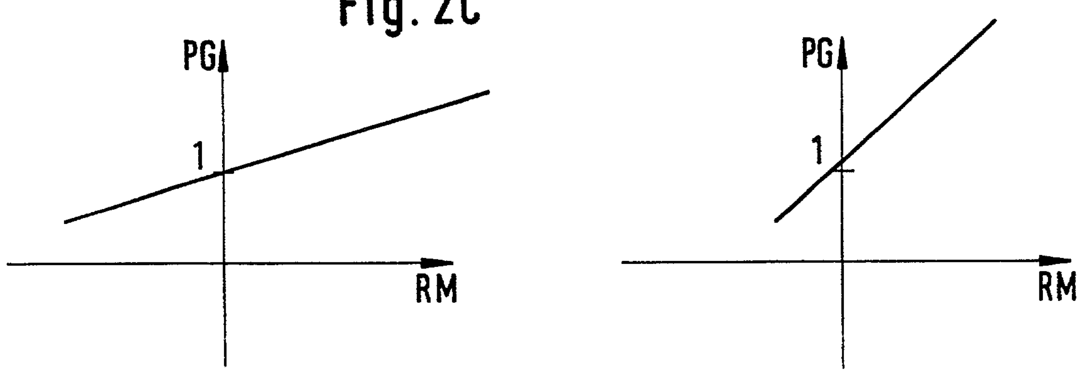


Fig. 3

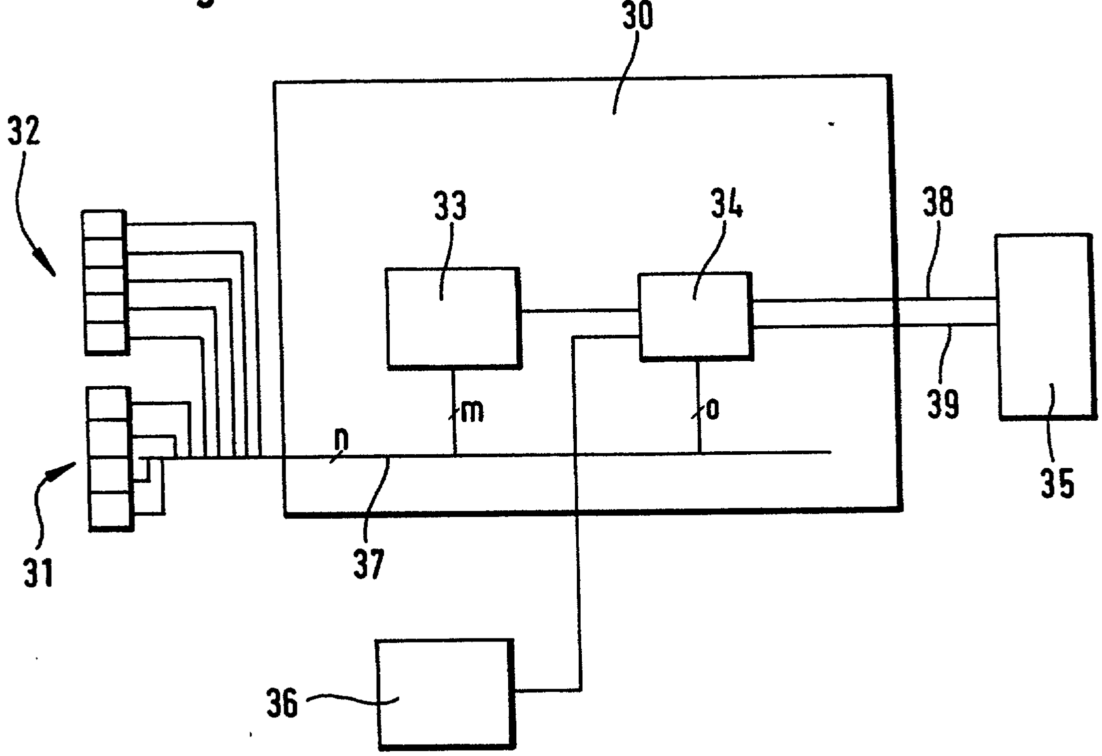


Fig. 4

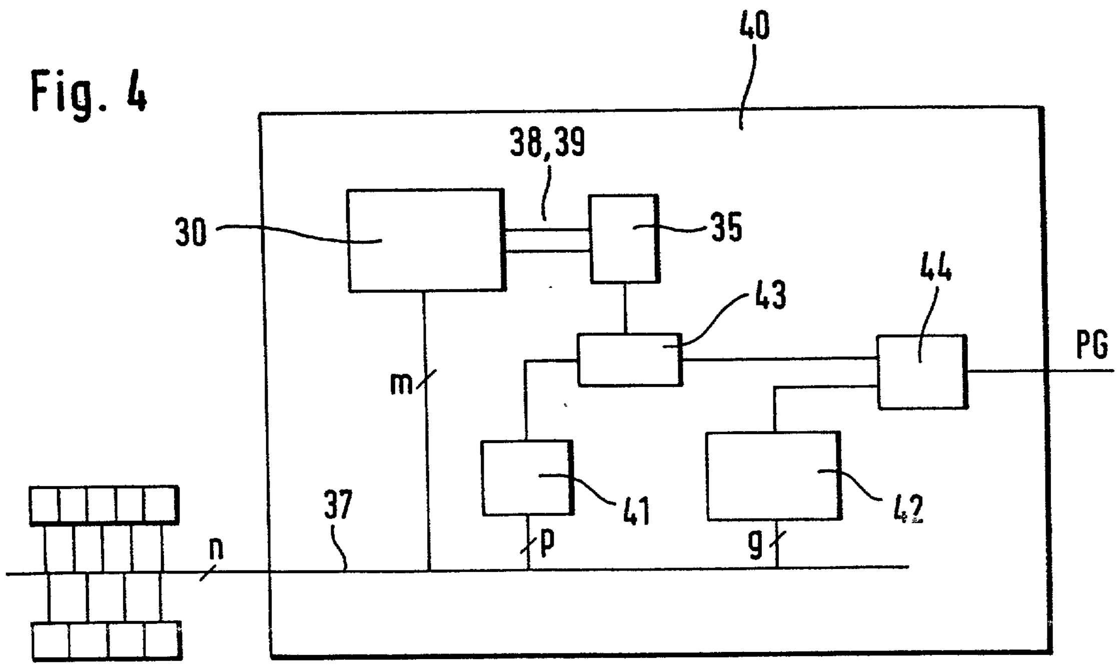


Fig. 5

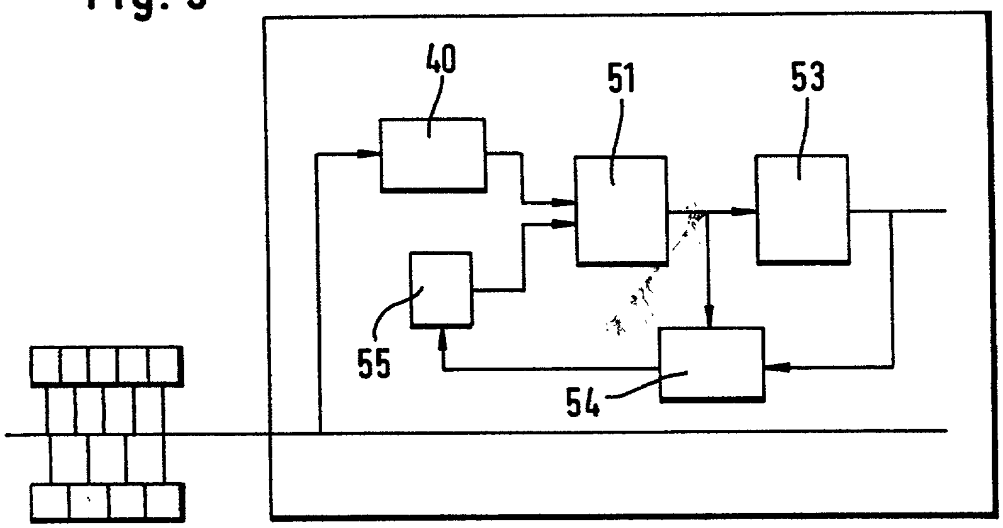
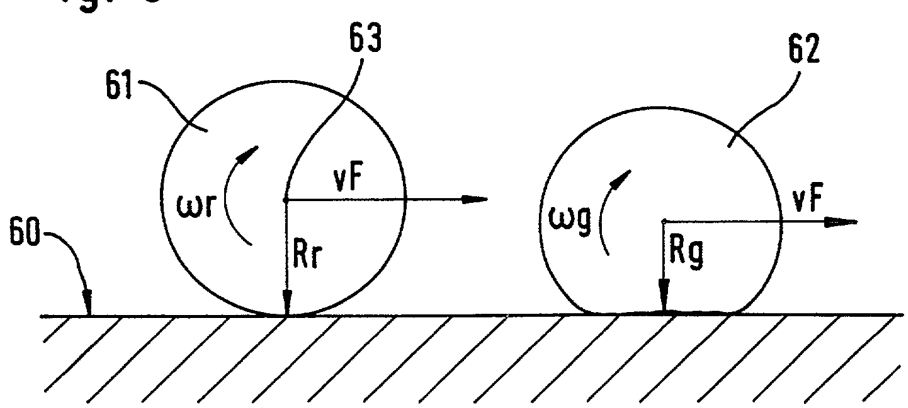


Fig. 6



EV051007674US

Declaration and Power of Attorney for Patent Application
Erklärung für Patentanmeldungen mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

daß mein Wohnsitz, meine Postanschrift und meine Staatsangehörigkeit den im nachstehenden nach meinem Namen aufgeführten Angaben entsprechen, daß ich nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent für die Erfindung mit folgendem Titel beantragt wird:

My residence, post office address and citizenship are as stated nex to my name.

I believe I am the original, first and sole inventor (if only one nam is listed below) or an original, first and joint inventor (if plura names are listed below) of the subject matter which is claimed an for which a patent is sought on the invention entitled

Verfahren und Vorrichtung zur Erstellung einer Korrekturwerttabelle, zur Ermittlung einer Prüfgröße und zur Erkennung des Druckverlusts in einem Reifen eines Rades

Method and Device for Creating a Compensation Value Table, for Determining a Test Variable, and for Identifying the Pressure Loss in a Tire of a Wheel

deren Beschreibung hier beigefügt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

the specification of which is attached hereto unless the following box is checked:

☒ wurde angemeldet am **02.06.2000** unter der US-Anmeldenummer oder unter der Internationalen Anmeldenummer im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT) **PCT/EP00/05033**

☒ was filed on **06/02/2000** as United States Application Number or PCT International Application Number **PCT/EP00/05033**

Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Patentanmeldung, einschließlich der Ansprüche, die durch einen oben erwähnten Zusatzantrag und in einem „preliminary amendment" abgeändert wurden, durchgesehen und verstanden habe.

I hereby state that I have reviewed and understand the contents o the above identified specification, including the claims, a amended by any amendment referred to above and as amended in a preliminary amendment.

Ich erkenne meine Pflicht zur Offenbarung jeglicher Informationen an, die eventuell zur Prüfung der Patentfähigkeit in Einklang mit Titel 37, Code of Federal Regulations, § 1.56 von Belang sind.

I acknowledge the duty to disclose information which is material t patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

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I hereby claim foreign priority under Title 35, United States Co §119(a)-(d) or § 365(b) of any foreign application(s) for patent inventor's certificate, or § 365(a) of any PCT International applicati which designated at least one country other than the United States, list below and have also identified below, by checking the box, any forei application for patent or inventor's certificate, or PCT Internatioı application having a filing date before that of the application on whi priority is claimed.

Prior Foreign Applications
(Frühere ausländische Anmeldungen)

19.06.1999	**DE 199 28 138.6**
19.06.1999	**DE 199 28 137.8**
10.12.1999	**DE 199 59 554.2**

19.06.1999	**DE 199 28 138.6**
19.06.1999	**DE 199 28 137.8**
10.12.1999	**DE 199 59 554.2**

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s)listed below.

Ich beanspruche hiermit die mir unter Title 35, US-Code, § 120 zustehenden Vorteile aller unten aufgefuhrten US-Patentanmeldungen bzw. § 365(c) aller PCT internationalen Anmeldungen, welche die Vereinigten Staaten von Amerika benennen, und erkenne, insofern der Gegenstand eines jeden fruheren Anspruchs dieser Patentanmeldung nicht in einer US-Patentanmeldung, bzw. PCT internationalen Anmeldung in in einer gemäß dem ersten Absatz von Title 35, US-Code, § 112 vorgeschriebenen Art und Weise offenbart wurde, meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Title 37, Code of Federal Regulations, § 1.56 von Belang sind und die im Zeitraum zwischen dem Anmeldetag der früheren Patentanmeldung und dem nationalen oder im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesen (PCT) gültigen internationalen Anmeldetags bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and. insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

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Martin Grießer Dr. Martin Grießer 21.11.01	2-00 H-G Ihrig Hans Georg Ihrig 21.11.01
Signature Date	Signature Date
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Citizen of Germany	Citizen of Germany
	Full name of fourth joint inventor, if any
Signature Date	Signature Date
State/Country	Street Address City State/Country
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